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Editorial

WE CAN'T PLAY THAT GAME

IN AN article in the May issue of the *Bulletin*,[1] it was argued that the drive for secrecy in atomic and other scientific and technical affairs is bound to remain largely futile in a society which is not under strict regimentation. It is likely to lead to a deceptive feeling of security, ending in bitter awakening—such as has occurred in the spy trials in Canada, England, and the United States.

If a demonstration was needed to show how the search for security in imaginary secrecy can be reduced *ad absurdum*, this demonstration has been provided by an action which has just come to the attention of the *Bulletin*.

In fulfillment of an order issued by the Department of Commerce on March 2, 1951, the U.S. Post Office refused to continue mailing the *Bulletin* to addresses behind the Iron Curtain. According to a letter to the *Bulletin* from Mr. Foster, chief of the Project and Technical Data Division of the Office of International Trade in the Department of Commerce, the department has revoked the general license for export of technical publications to all countries of the Soviet bloc. No special licenses are being issued, pending a decision on "desirability of the continuation of the exchange of technical information with these countries."

Classification of the *Bulletin* as a "technical publication" is something with which we disagree. The *Bulletin* does not contain technical articles of value to scientists or engineers in special fields, but only articles devoted to political, social, and military implications of scientific discoveries and, occasionally, summaries of progress in various important fields of science, based on generally available information.

Our major objection to the order is, however, not against the classification of the *Bulletin* as a technical journal; it is against the superficial plausibility and fundamental foolishness of the whole business. On the surface, the prohibition may seem both just and wise. If the Soviet Union does not permit the export of technical publications, is it not just that we should refuse to send her ours? Is it not obvious wisdom to stop supplying the Soviet Union with scientific and technical information which she might (and probably will) use to increase the military threat to America and her friends?

Undoubtedly, these arguments must sound convincing to many Americans. The issuance of such an order might prevent attacks on the Department of Commerce by zealous security guardians in and out of Congress. The simple fact is, however, that restrictions of this kind cannot deprive the Soviet scientists and engineers of one iota of information. The *Bulletin* and all non-secret technical literature, printed in America and in other free countries, is accessible to everybody willing to pay for it, beginning with the Soviet Embassy in Washington. (If the export prohibition applies to the extra-territorial embassies as well, they will have to cross the street to the nearest book store.) This literature can be freely bought, mailed, and copied by everybody in America, Europe, or non-communist Asia. The Soviet Union can have no difficulty in acquiring abroad and sending home copies of all publications of interest to her. She is not a party to the international copyright agreement, but even if she were, this would hardly stop her from reprinting and distributing important American technical articles, if not enough copies of them arrived from abroad.

The March 2 order, supposedly protecting American scientific and technical developments from coming into Russian hands, is therefore of no practical value. The effort to which the Soviet officials might now have to go to assure continued flow of information which freely reached Russia before the order was issued, can be only a minor nuisance to them. It reminds one of the story told on the Manhattan Project about a scientist who allegedly had been reprimanded by the Security Officer for mentioning in public a certain physical constant. When the scientist pointed out that this constant already had been officially revealed, he was told it had been published in metric units, while he had announced its value in pounds and inches. "Why make it easier for the Russians?" he was told.

* * *

When the Soviet Union restricts the export of technical literature (by the way, she has not yet made this restriction general, so that many scientific journals from beyond the Iron Curtain are still regularly received in America), she can do this with a fair chance of success. Soviet police organs can keep tabs on all subscribers to a technical magazine in the Soviet Union; they can reasonably hope to be able to prevent even a single copy of it from finding its way beyond the Iron Curtain. If the control is not yet tight enough in the satellite countries, the Soviet Union can (and does) prohibit the export of such literature into the satellite countries as well. In short, when the Soviet government prohibits the exportation of technical journals, this prohibition makes sense. When the American government imitates the Soviet government, it makes a futile gesture. The difference is like that between an animal that buries itself completely underground, and the ostrich that buries only its head—and pretends that no one can see him.

There is no way to make a secrecy measure of this type effective in America or Western Europe, short of changing the free way of life, and placing police control over all movements of men and mail. Some may say: Even if the measure is futile, why protest it? Admitted it does no good, does it do any damage? At least, it gives the kind of satisfaction that "retaliation in kind" affords unthinking people.

The answer to this is that such policies do damage in two ways. In the first place, they create false security values; they call for investigation and persecution of breaches of imaginary security barriers, and in gen-

[1] Eugene Rabinowitch, "Atomic Spy Trials: Heretical Afterthoughts," pages 139–42, 157.

eral, unnecessarily restrict the freedoms which we are set to protect.

In the second place, retaliation measures of this type plug up the thin flow of Western ideas and ideals that still reaches the people living under communist dictatorship. The fact that America and other countries of the West are following the example of their own rulers in restricting the exchange of scientific information tends to convince intelligent people in Russia, Poland, Eastern Germany, and other communist-dominated countries —who still remember their past freedom of communication, and yearn for its return—that lights have gone out all over the world, and that the Western governments, who claim to defend this freedom, are as little to be believed as their own. They feel themselves betrayed by and cut loose from their friends.

We have no delusions about the *Bulletin* copies which used to go to the countries behind the Iron Curtain being freely read, circulated, and commented upon among our colleagues there. In the Soviet Union, in particular, we are certain that they went primarily to persons assigned to interpret the *Bulletin's* articles from the point of view of their political and military implications, and reached only a few of our fellow-scientists. In the satellite countries, the controls undoubtedly are less airtight, even if there, too, the screws are being tightened with every passing day. However, we believe that even reaching only readers specially selected for their loyalty in the countries of communist dictatorship is valuable. Even these people cannot help being influenced or shaken in their beliefs by what they read; even they cannot quite avoid talking to their friends, or otherwise serving as conveyors of the ideas and attitudes coming from the West. It may be but a trickle of fresh water penetrating through the wall and carefully directed into cemented wells, or gravel pits where it soon drys out; but to turn this trickle off voluntarily is not a policy to be recommended to the free world.

—E. R.

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THE BRITISH AND THE BOMB

STEWART ALSOP

In the following article Stewart Alsop, the well-known Washington columnist, examines the influence of the threat of atomic bombing on the political attitude of the British people.

THE threatened rupture of the Anglo-American alliance, dramatized by General MacArthur's recall and Aneurin Bevan's resignation, has much deeper roots than most people realize. For the fact is that the British planners and military chiefs are more and more inclined to challenge the basic concept on which American strategy rests, and thus in a sense, to challenge also the basis of the Anglo-American alliance.

The heart of the matter is that American strategy is now squarely based on atomic bombing of great population centers—and the British Isles themselves are fatally vulnerable to just this form of attack. This is certainly one reason why the British have already proposed, at least informally, that if war comes, American atomic bombs should not be used against Soviet or satellite cities, except in retaliation for Soviet attacks on American or allied cities.

BRITISH THESIS

The British are urging, that, unless the Soviets first use their atomic stockpile for population bombing, the American stockpile should be used only against communication lines, special isolated targets, and tactically against enemy troops in the field. This proposal is based on the assumption that even in war the Russians probably would not use their bombs against allied cities if they knew this would cause devastating retaliation against Russian cities.

This may be wishful thinking, but in the terribly exposed position in which the British find themselves, wishful thinking is natural. The British also advance a second, and very powerful argument for their proposal. This is based on a point made by the great American expert on Russia, George Kennan, in a recent issue of *Foreign Affairs*.

"We in the outside world," wrote Kennan, "... will never prevail in any struggle against the Soviet power unless the Russian people are our willing allies. That goes for peace, and it goes for war."

The British argue—and Kennan would doubtless agree—that the Russian people are not going to be "our willing allies" after 30,000,000 or so Russians have been killed by our atomic bombs. They argue that mass population bombing, except in retaliation, would be as fatal an error as Hitler's savagery in Russia, cementing the people around the regime, and thus ending all hope of quick or decisive victory.

Unfortunately, there are very cogent reasons why the British proposal will almost certainly be rejected. For one thing, there is the nature of the bomb itself. In certain special circumstances, the atomic bomb can undoubtedly be used effectively as a tactical weapon. Yet the brutal fact is that the atomic bomb is inherently suited, not for use against isolated targets and troops in the field, but for use against the massed populations of great cities.

EFFECTS OF THE BOMB

In Hiroshima and Nagasaki, the three primary effects of the bomb—blast, heat flash, and radiation—caused only a small fraction of the casualties. The great bulk of casualties are caused by the city itself, when blast collapses buildings on top of people, and when both blast and heat flash start terrible fires. The cruel truth is that the atomic bomb is only a really revolutionary weapon when it is used in this way—to cause great cities to destroy their inhabitants.

Used in any other way, the bomb is no longer a decisive weapon. Heavy industrial machinery is not essentially damaged by the blast of a modern bomb, even under a mile from ground zero, the point above which the bomb is exploded. A soldier in a slit trench would almost certainly live to fight another day only a mile from ground zero, and a tank would remain essentially intact well under half a mile from ground zero.

Even assuming that many hundreds of bombs were available for tactical use, or against isolated targets—and each bomb represents a very heavy investment—the effects could not be decisive. A weapon with a killing radius of not much more than a mile cannot stop a numerically superior army advancing across a fluid front of many hundreds of miles.

Thus to accept the British proposal would be the equivalent of very sharply reducing the American atomic stockpile. And the American atomic stockpile is the central military asset of the West, and the only real existing deterrent to Soviet aggression.

The fact is that the follies of past disarmament have reduced this country and its allies to total reliance on a willingness to use the atomic bomb, in the most ruthless way, for the awful purpose for which it is inherently suited. Yet it should not surprise us that the British and our other European allies are not precisely eager to join us in a crusade which would see their countries either occupied or devastated. And if there is no war soon, and General Eisenhower succeeds in his mission of building real strength in Europe, the time may indeed come when it will be well to reexamine a strategic concept based wholly on a weapon likely by its very nature to defeat all our purposes.

Reprinted with permission from April 30th *New York Herald Tribune*.

PRESENT ROLE OF THE NATIONAL SCIENCE FOUNDATION

ALAN T. WATERMAN

The following article by Dr. Alan T. Waterman, who was recently appointed director of the National Science Foundation, tells of the current activities and future plans of the foundation. Dr. Waterman was formerly technical director of the Office of Naval Research.

I WELCOME the opportunity to report that the National Science Foundation is at last under way. This event is one which most of us have anticipated with a good deal of eagerness and even anxiety, during the five years of its germination.

It is a cause for satisfaction that the National Science Foundation should have been established and not postponed or forgotten amid the stresses and tensions of the present world situation. For although the NSF has deep significance in the national defense, as I shall presently indicate, its primary importance is as a bulwark to our national culture and our industrial economy. The able members of Congress who fought for the foundation in spite of the heavy pressures and competing needs of the post-war period are to be congratulated on their vision and imagination. For in the long run it will avail us little to provide for the physical needs of the moment—however vast these may be in terms of weapons and armament—if we are not at the same time reinforcing and broadening the firm base upon which our economy and our civilization rests.

Most of you will recall that the NSF was originally proposed in Dr. Bush's report to the President, *Science the Endless Frontier*, which was published in July 1945. Hearings on legislation to implement the proposal were started in October of that same year. Twice the bill was passed by the Senate, only to die in the House. Finally, during the second session of the 80th Congress, both Houses passed a bill, which was disapproved by the President on the basis of his objections to the administrative structure proposed for the foundation. The bill which was finally enacted into law was approved by the President on May 10, 1950. The ensuing months have been taken up with the appointment of the twenty-four-member board, of which Dr. James B. Conant is chairman, and other business directed toward the implementation of the act.

Within the last few weeks the foundation has begun to set up housekeeping in its temporary headquarters at 901 Sixteenth Street, Washington, D.C. We have no scientific staff as yet and our operations for the immediate future must necessarily deal with the elementary facts of government existence. Nothing can be definitely planned, of course, until our budget for the coming fiscal year has been presented and approved. I am not going to bore you with the complexities of present activity in the foundation but I should like to say a few words about what we think its role should be in the next few years.

CURRENT PLANNING

One of the most striking phenomena of the last decade has been the emergence of science and technology as one of the decisive factors in world affairs. I venture to say that no one present at the historic meeting at the Carnegie Institution of Washington on January 26, 1939, could have predicted that the speculations of Bohr and Fermi would start a chain of events in which nuclear physics would produce a decisive instrument of world politics. Applied research and technology have made unparalleled progress during this same decade but they have also made heavy inroads on the stores of basic knowledge, and the supply of trained scientists and engineers has fallen far short of the demand. In these two areas the foundation can perform its greatest service by strengthening basic research and helping to increase the numbers of scientists and engineers. Most of you, I expect, are familiar with the functions of the foundation as prescribed in the act. The first of these is the development and encouragement of national policy for the promotion of basic research and education in the sciences. The NSF will have contractual authority to initiate and support basic scientific research in the mathematical, physical, medical, biological, engineering, and other sciences. One of our first steps will be to set up divisions covering the specific fields mentioned.

The foundation is also authorized to award scholarships and fellowships in these fields of science. In view of the critical situation with respect to scientific manpower and the length of time it takes to produce a trained research scientist, we believe it is important for the foundation to proceed at once to initiate a fellowship program which will include graduate fellowships and a limited number of postdoctoral fellowships. A second major activity of the foundation will be the encouragement of fundamental research throughout the country for which the foundation proposes to award grants or contracts to individuals or groups in cooperating research institutions. It is hoped to support exploratory research by competent scientists whose work is now handicapped by inadequate financial resources.

The foundation will seek out promising scientific talent and new ideas which appear to be worthy of support and encouragement. The foundation appreciates the fact that effective research often means years of uninterrupted work before it can be brought to fruition. In order that its support may meet this condition, the board proposes to make its grants and contracts good for extended periods of time.

Address given at meeting of the American Physical Society in Washington, D.C. on April 27, 1951.

I judge that one of the questions in many minds is the relation of the National Science Foundation to the Office of Naval Research. May I assure you at once that the program of the Office of Naval Research is in sound shape and in most capable hands. Its basic research program is in more stable condition that ever in its history. It is true that of necessity the Office of Naval Research will have to devote concentrated attention upon bringing the results of basic research and the competence of many of its key investigators to the aid of the emergency defense program. This is as it should be and forms a striking justification of the whole activity of that office.

FUNCTION OF NSF IN PRESENT EMERGENCY

And now, having told you something about the current planning on the part of the National Science Foundation, in so far as an embryo can do some planning, it seems to me that you might care to have me make some remarks on the relation of the program under the National Science Foundation to the work of scientists that is relevant to the present emergency. I can give you a few preliminary ideas on this subject, which, although preliminary, I believe personally to be sound. Secondly, I hope you will bear with me if I make a few personal remarks based on my observations at this time of the future position of physics and physicists.

First, what should scientists, and physicists in particular, do with respect to the present emergency? This was a problem on which we did a great deal of thinking and consulting in the Office of Naval Research. Let me begin then by outlining the general conclusions that we reached. On the assumption we are faced with some degree of national emergency and that the degree and duration of this emergency are quite uncertain, then we should, with all dispatch, put ourselves into what the military would call operational readiness. Furthermore, we should take whatever steps we find necessary to maintain ourselves in that state of operational readiness for an extended period, perhaps for many years. This we should do with the realization that, at any time, the emergency may turn into a crisis and total mobilization be upon us.

As Secretary Marshall commented to the American Association of School Administrators last winter:

"The danger of communist attack is not transitory. There is reason to believe that it will continue for years, until the popular strength of democratic institutions is again firmly established in the world. It therefore behooves us to set up a system that we can sustain during the next decade without bankrupting ourselves. Common prudence should dictate such a decision."

If these be true assumptions, what then do we mean by operational readiness from the standpoint of science in general and physics in particular? My interpretation would be that we should take immediate steps to see that, from the scientific and technical standpoint, the military services are fully prepared. This means that scientists should play their part today in seeing that really urgent applications of science which are capable of being put to practice in a short period, say two or three years, should be expedited. Obviously, this should be done with all the care that can be spent on an emergency job. We know the country certainly can not undertake all possible scientific applications in a limited period and hope to complete them in time for operational use. Therefore, there must be careful selection as to the practical developments which are both feasible and of high priority. And it is most important that this selection be made not by scientists alone nor by the military alone but by both jointly.

This step represents only one phase of our planning. A second phase which should be considered simultaneously is concerned with the necessity of maintaining our scientific readiness over a period of years. To meet this necessity we should, in my opinion, do our utmost to strengthen our national scientific program and maintain that strength at the highest level possible. It is absolutely clear this must be done for two all-important reasons:

1. We must achieve and maintain scientific progress at a maximum level. This is only one way of saying we must, with our limited manpower, keep the initiative, scientifically speaking, in as true a sense as we keep the initiative with respect to the effectiveness of our military forces.

2. We must start an active program for training scientists, especially young scientists, in order to meet the urgent needs that will arise for military purposes and for all purposes relating to efficiency and strength in our national economy.

If these assumptions are valid, then the National Science Foundation has a clear duty, first to lend vigorous support to basic research in all fields of science and, second, to back a strong program in support of scientific training and education, especially at the graduate or research level. Both undertakings are especially necessary during the emergency.

PRESENT SITUATION IN PHYSICS

I mentioned earlier that I might venture some random personal thoughts concerning the present situation in science and in physics in particular. No originality is claimed for these thoughts for they are the result of ideas which have been tossed back and forth among many people. In the first place, if we assume that physicists are going to be in great demand and in special demand for research and development related to military needs, then we should take thought of what may be the effects upon progress in physics itself. In adopting this point of view for the moment, I am not implying that the results of any thinking along these lines should necessarily affect our course of action with respect to the part played by physicists in national defense. My feeling is rather that in attempting this kind of analytic forecast with respect to our subject and in keeping distant goals in mind, we shall also have done our best by the present situation.

Let us suppose that a certain fair proportion of physicists will be called directly into defense research and that, at the same time, we shall succeed in establishing a firm core of fundamental research at universities and similar institutions for the advancement of learning and education. The demands of the defense effort and of industry may be expected to attract increasing numbers of young men and women to the study of physics both as undergraduates and graduates. Many of them will be attracted because of the opportunity for good jobs in the future. One of the problems for our educational system will be how to provide adequately for the increased numbers of students. There will be a corresponding need for an increase in the number of teachers of physics and, hopefully, an increase in the number of good teachers. We may guess that this influx of young physicists, together with the emphasis on applied physics, may produce a trend toward what might be called the "practical training" of physicists. Now, applied physics is certainly most important and should not be belittled in

any way. It calls for the development of individuals with talents somewhat different from the talents of those who pursue knowledge for its own sake. They may be no less gifted and certainly no less able. However, when this has been said, it is pertinent to add that the point of view of a large group whose aims are identified with applied physics may tend, by its social pressure, to draw attention away from the most fundamental aspects of the subject. Granted that there will always be individuals who will not be so diverted, and that among them will be those best equipped to follow physics for its own sake, nevertheless, their number may not be large enough to assure proper attention and progress in the pure field of science. Practical need and justification of budgets are powerful factors. You doubtless recall Dr. Bush's remark in *Science the Endless Frontier* to the effect that applied research drives out basic. My point is that for the sake of progress in a field so necessary to national welfare and security, and also for the sake of physics itself, we must run no risk of neglecting the fundamental research approach. May I add that there is no danger that fundamental research in physics will be neglected as long as there are bright sparks of progress appearing regularly from time to time. There is no question that the greatest incentive derives from the exciting discoveries, bits and pieces though they may be, which appear from time to time in a healthy science as they always have in physics.

Finally, in the pursuit of significant advances which may serve to chart progress in the field, it may well turn out, as history so often records, that the way will more often be pointed by individuals than by groups. It is true that the basis for an individual's work in this day and age may reside in a group activity such as the operation of a high energy accelerator. But it is my hope that along with these team efforts we may also make it possible for gifted individuals to work as they always have done along the directions in which their insight may lead them. This again is a matter in which the National Science Foundation may lend a hand.

In conclusion, may I say that the National Science Foundation will be successful in its aims only to the degree to which it enjoys the cooperation and sympathetic understanding of the national scientific body as a whole as well as of the scientists who take part in its program.

GENERAL MacARTHUR: WAR IS OBSOLETE

The following quotations are from the transcript of General MacArthur's testimony before the Senate Committees on Foreign Affairs and Military Affairs on May 4 and May 5. They come from a man who has spent fifty years—practically all his life—in the army. They should be heeded by those who speak lightly of "preventive war," and those who deem themselves wise when they say "wars have always been and will always be."

SENATOR FULBRIGHT. General, would you care to say whether or not you feel that war with Russia is inevitable?

GENERAL MacARTHUR. No, sir, I do not feel that war is inevitable. I believe that the great masses of the world, what you might call the ordinary men of the world, are invincibly against war.

I believe that is so among the Russian masses, just as it is among our own people.

I believe that the great tragedy of the world today is that we have not been able to establish the mechanics to carry out the will of the common people that war shall be nonexistent.

I believe that the same impulses against the destructiveness of war exist in all people.

Now, war, you have got to understand the history of war; you have got to understand that in the beginning it was a sort of gladiatorial contest in which, when the opposing parties disagreed, they would agree to abide by the decisions of this gladiatorial contest. I suppose the beginning was the David and Goliath story in the Bible. It progressed from that into small professional armed forces, which would fight in some obscure corner of the world, but the results of that would be accepted in the chancelleries of the world, and the peace would be written.

Gradually, with the scientific methods which have made mass destruction reach appalling proportions, war has ceased to be a sort of the roll of the dice to determine what the winner should be—which should be the winner, and dictate the terms.

It has become an all-out effort. It has involved every man, child, and woman in the whole world. The integration of the world into this compressed community now which exists has involved everybody.

I tell you it has outlawed the very basic concepts, gentlemen, upon which war was used as a final word when politics failed to settle international disputes. It is inherently a failure now.

The last two wars have shown it. The victor had to carry the defeated on his back. I have been carrying with all the resources I possessed, and with the noble help of this country, that defeated country Japan, trying to save her from destruction and win her back into decency.

We paid, perhaps, two billions of dollars in that effort. We have been doing the same thing with Germany. We did win the war, but we did have to carry the loser.

If you have another world war, you are going to get such destruction and destructiveness. I think it was a philosopher who said: under such conditions only those will be happy that are dead.

Now, the masses of the world are far ahead of their leaders, I believe, in this subject. I believe it is the massed opposition of the rank and file against war that offers the greatest possible hope that there shall be no war.

I believe it is the confession of defeatism in our civilization to say that war is inevitable. I believe the greatest mistake that was made in the League of Nations was not to tackle that fundamental problem.

It represented the highest hopes and concepts of mankind, and its main mission was to keep the peace, but it developed into a body which had all the weaknesses of a legislative group, which could not speak with the authority of elected representatives; it had all the weaknesses of a judicial forum which did not have the moral and spiritual code which gave conviction to the world at large in its decision, and, executively, it had all the weakness that it did not have the agencies under its control to carry out its decisions. It still remains a hope.

★ ★ ★

SENATOR MCMAHON. Now General, have you any hope for us in finding the formula which will settle the whole matter?

GENERAL MACARTHUR. I tried to expound it yesterday, Senator.

It is the abolition of war.

It takes long decades, of course, before that could be accomplished; but, you have to make a start. There is no halfway substitute. You, of all men, should know that, as the expert in atomic warfare.

SENATOR MCMAHON. Just the legislative representative, General; not too expert.

GENERAL MACARTHUR: And, the sooner we tackle that basic problem—it is no more difficult to settle that problem than it is these various problems that come up, that are corollary to it.

I believe that that should be done.

There was great evidence of that in Japan.

You spoke of Hiroshima and Nagasaki.

So, the Japanese people, more than any other people in the world, understand what an atomic warfare means. It wasn't academic with them. They counted their dead, and they buried them.

They, of their own volition, wrote into their constitution a provision outlawing war.

When their Prime Minister came to me, Mr. Shidehara, and said: "I have long contemplated and believed," and he was a very wise old man—he died recently—"long contemplated and believed that the only solution to this problem is to do away with war."

He said: "With great reluctance I advance the subject to you, as a military man, because I am convinced that you would not accept it; but," he said, "I would like to endeavor, in the constitution we are drawing up, to put in such a provision."

And, I couldn't help getting up and shaking hands with the old man, and telling him that I thought that was one of the greatest constructive steps that could possibly be taken.

I told him that it was quite possible that the world would mock him—this is a debunking age, a cynical age, as you know—that they would not accept it; that it would be an object of derision, which it was; that it would take great moral stamina to go through with it, and in the end they might not be able to hold the line; but I encouraged him and they wrote that provision in.

And, if there was any one provision in that constitution which appealed to the popular sentiment of the people of Japan, it was that provision.

There was a warrior tribe which, for centuries, had pursued war, and successful war; but the great concept, the losses, the great lessons the bomb had taught them, had been understood, and they were trying to apply it.

Now, the world should have common sense enough, when it surveys the last two wars, to understand what I tried to bring out yesterday, and my own thought—that it had become the method of suicide for modern civilization, if they engaged in this type of combat.

I therefore believe that time is running out on us.

I said, at the end of the World War, the Second World War, that we have had our last chance, and I believe it firmly, and as I said yesterday, I believe that 99 per cent of the people of the world believe that.

It is the establishment of the mechanics that are so difficult.

That, Senator, is my suggested solution, that you try, through the United Nations, or some other forum, to get an agreement with the nations that they will accept that formula and try to have their constitutional bodies, their legislatures debate it and see who are the people that stand out against it.

I understand thoroughly that no one nation is going to put it into effect, until practically all do—all the great nations do, anyway.

The great nations would set the norm.

If the four or five great nations should do it, it would be impossible for anyone else to violate it.

Discuss that, and if you have to pass such a legislative fiat, do it conditionally, upon the others—take the moral leadership of the world, which is ours, and try something like that.

We are not making great progress along the normal line of diplomacy.

That, Senator, if I should have the temerity to make a suggestion, and I only do it in response to the questions that have been asked—would be my answer.

SENATOR FULBRIGHT. Are we pursuing a futile policy in our efforts to abolish war? I consider everything we have done under the United Nations as being motivated by the purpose of abolishing war. Is that a wrong, futile, and naive approach, or is it not?

GENERAL MACARTHUR. I think every effort that is made to abolish war or the causes of war, which are well known to every rational, reasonable man, is a noble and proper purpose.

SENATOR FULBRIGHT. General, that is not responsive to my question. I asked you: Is the effort we have made—

GENERAL MACARTHUR. I haven't any idea of trying to answer directly your question. I don't think it falls within the scope of my knowledge or that I am qualified to discuss such a subject before this distinguished group.

SENATOR FULBRIGHT. You mean you don't feel qualified to say whether or not the United Nations and what we have done in that direction is a step toward the abolition of war, in your opinion? You don't feel qualified to make any expression about that?

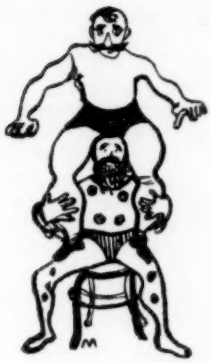
GENERAL MACARTHUR. I have only the barest knowledge of what has transpired in the United Nations. I have never been connected directly with their sessions.

There are many, many things that have occurred that I have no knowledge of at all. I wouldn't attempt in the slightest degree to pass judgment on that distinguished body. I don't know enough about what they have done.

I am sure—and I have said here—that their ultimate purpose, the mission that they are working for, is one of the highest and noblest that the Christian world has ever known.

Now to discuss in detail things that I don't know anything about would just be foolish and foolhardy on my part.

THE ORIGINS OF THE SCIENTIFIC SPECIES



RICHARD L. MEIER

Professor Richard Meier of the Program of Education and Research in Planning at the University of Chicago and executive secretary in 1947 of the Federation of American Scientists attempts a sociological interpretation of the typical political, social, and cultural orientations of chemists, physicists, biologists, and engineers.

HAVE you ever had a conversation with a scientist and then started to wonder why and how he became what he was? Did you ever feel instinctively that one investigator was typical of his profession and that another in many ways was exceptional? Impressions like this imply that there must be some regularities in the social origins and personalities of scientists. Not only do they seem to come in distinct species, but in recognizable varieties within the larger subdivision.[1]

Most scientists in America today made the critical decision during the '20's and '30's which led eventually to the laboratory or the designing room. Somewhere between the ages of ten and eighteen the issue was settled for each of them and after that, education, work, and even many pleasures were closely conditioned by the choice. The most remarkable feature one encounters over and over again is the large proportion of scientists who chose their careers on the basis of virtually no information or experience relating to what was really involved in the scientific professions. Very few are able to isolate and identify the underlying motivation. Thus the original choice was usually subjective in nature, and therefore highly unscientific—according to standards later acquired.

The essential clues to a generalized picture lie in the social milieu of the '20's and '30's. This was the era of *Main Street, Dodsworth, Arrowsmith,* and *The Big Money.* There was a rapid, chaotic urbanization and a decline of the rural community. It became generally recognized that henceforth the pathway to higher social status and economic security led through the colleges and universities to the professions and managerial posts. Thus the land grant universities doubled and redoubled their registration, and the enterprising country colleges did almost as well. Any institution with tuition low enough to permit a fellow with grit and determination to work his way through obtained a fair cross-section of the bright youngsters of the period. Student bodies ranging west from Penn State and North Carolina developed remarkably similar social environments whereas the Ivy League schools, due to tradition and high tuition, remained individual and atypical; and New York City, because of the press of recent immigrants, developed into a special case.

THE CHEMISTS

Chemists are the most abundant of the scientific species. Their origins have on the whole been neither humble nor magnificent, but mainly lower middle class. They are sons of schoolteachers, small businessmen, successful farm owners, and lesser folk who had strong ambitions toward joining these ranks but, for one reason or another, failed. As youngsters they were encouraged to read widely, but the channels available were limited because more than three-quarters grew up in a Main Street atmosphere. They became both curious and romantic. Therefore it was quite natural that, when the subject of career came up, a profession was seized upon which was novel, romantic, and offered release from the tedium of the small town. The books available in small Carnegie libraries or high school collections had much to do with this decision, since all had such titles as *The Romance of Modern Chemistry* and *Science Remaking the World.* The fact that chemists were getting jobs when other graduates were unsuccessful was also a powerful argument, but this was known only to a minority at the time of decision.

During most of the inter-war period more than half of all entering science students were chemistry majors. They were pressed into laboratories well beyond their rated capacities. Many were ruthlessly flunked out, but those who remained were of the same background as those who failed. No real selection occurred until the junior year when those who could not comprehend thermodynamics drifted into biochemistry, bacteriology, ceramics, and related fields. Those who mastered this subject went on to become chemical engineers or chemists, either organic or physical. Thus chemistry tended to retain most of its best minds; graduate schools in the 30's were blessed with far more than their share of higher competences and rare intellects—a fact which reflects today in the thickness and quality of the research journals and the vigor of chemical technology.

[1] This analysis has been based upon discussions I have had with more than a thousand scientists scattered over the country. Such a survey is not strictly scientific because the sample could easily be skewed, but since a rigorous study is not justified (the present crops of scientists are evolving in quite a different fashion), this presentation is at least enlightening as to the kinds of interactions which occur between a society and its science.

The definition of the species used here has already been set down by the scientific and technical societies. Thus if a man identifies himself as a professional chemist and has the qualifications for being accepted as a member of the American Chemical Society he is *ipso facto* a chemist. Thus these generalizations cannot be applied to faculty members because they obviously are not a suitable cross-section of the profession. Representatives in industry and government must be included.

Chemists are seldom rebels or radicals. In an organization they grumble extensively but still are responsible, patient, and cooperative. They constitute at present the largest single reservoir of managerial talent in the technical area, and these capacities will be exploited even more in the years to come. The chemists' politics are usually a non-violent conservatism or liberalism (this depends upon your own vantage point) which is compatible with service both in corporations and in government agencies.

THE ENGINEERS

Whenever I talk to engineers about the current state of engineering they invariably make an exception of chemical engineers and their achievements. Why is this so? One man explained that chemical engineers have only a top dressing of engineering. Scratch a chemical engineer, he said, and you will find underneath nothing but a chemist who is used to dealing in tons rather than grams. Engineers are different.

He is right—everyone seems to agree that engineers *are* different. The bulk of today's engineers are more absorbed in their professional duties and less involved in either management or community activities. They are mostly apolitical, but when they do have views, these are of a stereotyped conservative nature. They find it difficult and exhausting to express themselves in writing or formal speech.

The reasons are not hard to find, since the engineer has had a harder struggle rising into the professional classes. Most engineers were sons of skilled workers, mechanized farmers, service workers, and the least literate of the lower middle classes. There was little encouragement to read at home but multifarious sports events to participate in, jalopies to fix, and miscellaneous contrivances to fiddle with. For these youngsters engineering was a subject where you learned "what made things tick." Thus it was natural to decide at ages 16–18, when the question of career came to a head, that one owed it to himself to go to college and become an engineer.[2]

Engineers had to contribute more to their own support while in college, and had a more demanding study program. There was no time to get a broad education when problem sets were demanding solutions. Thus it was natural that, on campus at least, engineering students became a race apart from the others, developing their own humor and informal associations. They failed gloriously in economics and English composition, but gained respect for their facility with the slipstick which dangled from their belts in a brown leather holster. Their bull-sessions were uninspiring because only two topics seemed to engross their attention besides course work, namely sports and sex.

Yet it would be unfair to draw these lines too sharply. At every engineering school there was an elite, much of it the sons or close relatives of contemporary engineers, but some from every section of society, who embraced a much broader conception of the world. They were as brilliant outside of the engineering school as they were within it. The real reputation of a school depended upon the size and capacities of this 5–20 per cent segment because today they constitute the cream of the profession—the consulting engineers and the top executives.

THE PHYSICISTS

The trials of the physicists came later in life. Most physicists (this category includes most astronomers, applied mathematicians, and some advanced electrical and electronics engineers) came from the upper middle class and the intelligentsia in general. Great numbers of them were sons of ministers, rabbis, deacons, cantors, and other church stalwarts. They were exposed from infancy to a wide variety of ideas, lived in homes with considerable libraries, and were nurtured on idealism, ethical behavior, and a rationalized morality. The ease with which they handled mathematical abstraction as youths made the unfolding physical world highly attractive. Here was something truly fundamental; here lay the secrets of the universe.

There were not more than a dozen significant physics departments in the United States before the mid-'30's, but Hitler's persecutions resulted in the great enrichment of American research starting at that time so that the production of finished physicists of all kinds reached a peak by 1941–42. Thus the bulk of the physicists were still absurdly young when the war directed their activity into two large-scale efforts—electronic devices, including radar, and the atomic bomb.

The physicist by nature is politically radical. His mind is schooled in the proposition that progress is made by discarding various assumptions and premises and thereby making it possible to create a more powerful theory upon a simpler underpinning. The physicist, more than any scientist, deals with abstractions which make nonsense out of observations based upon the commonplace; he is educated in doubt and can disregard evidence which to the ordinary observer is both convincing and conclusive. Thus many physicists chose a vague leftist political philosophy, partly as the only relatively rational set of value premises which was offered at the time ('36 to '40) in the world of ideas. The idea of an international community of science has from the beginning been very real to the physicists, while for the chemist it has been but dimly comprehended, and the engineer is almost completely oblivious.

The developments of the last decade have brought on many value conflicts within the minds of physicists which have often resulted in an apparent change of personality. No one hates secrecy with as much emotional vigor as a physicist, yet hardly any are more thoroughly afflicted with it. Everyone knows the disillusionment that accompanied the lack of international agreement on atomic energy but few can imagine the confusion of thought, the loss of goals, and even faith, that followed it. For many the fun has gone out of physics, they feel stale and unproductive.

THE VARIOUS BIOLOGISTS

The biologists are a complex assemblage. The profession can only be successfully described as the conjunction of several quite different streams of talent.

One important group has already been mentioned. These are the chemistry majors who bowed to thermodynamics and therefore moved into areas where their laboratory techniques were welcomed and the theory was less abstract. These were almost uniformly from the lower middle and professional classes and brought with them the same reasonable conservatism described earlier.

There is another group which is

[2] Margaret Mead suggested that these boys were canny enough to deduce "that it was really the engineer in the front office, and not the foreman, who was responsible for telling his old man what to do." This possibility of unconscious quest for power introduces a whole series of subconscious factors which might have been profession-determining during the '20's and '30's but are not reviewed here. I don't know how they could be adequately explored at this late date.

made up of exceptional minds which developed under agricultural surroundings. There was no material to experiment with in their early environment except the plants and animals which are the central theme of farm life. When these men got to college they enrolled in agriculture, botany, zoology, and related areas. The numbers of these scientists dwindled rapidly during the inter-war period because of the intrusion of urban values into the countryside. By 1940 it was mainly the South that was contributing any substantial number to this stream. A large share of the senior biologists in this country have such origins.

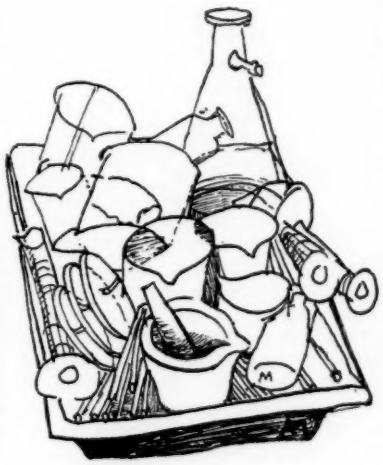
One doesn't think of this group as having any political orientation, yet I have often been surprised to detect attitudes voiced which hark back to LaFollette progressivism and quite radical-sounding ideas which were discussed widely in the farm areas in the days of William Jennings Bryan. Other than these few minor deviations, they seem to conform quite closely to the Protestant ethic.

Perhaps the largest portion of today's biologists aspired to become medics but were disappointed. One segment of these are the intensely ambitious and capable boys from poorer families who worked their way through college but were unable to finance medical school, and therefore turned their efforts to research in the biological sciences. The other segment came from middle class students who didn't make sufficiently high marks to gain entry to the medical schools and were therefore faced with loss in social status. Many drifted into pharmacy and dentistry but others became very high-grade technicians, often in applied research directions. A large number developed into ultra-specialists and so are able to maintain their self-respect as well as adequate incomes. In spite of the difference in social origins the political and social views of these men are remarkably similar to those exhibited by engineers.

ESTHETICS

Appreciation of music and the visual arts offers a striking demarcation of sensibilities between the scientific professions. The physicists, for instance, will show a strong preference for Bach. (I'm told that some *experimental* physicists will go so "modern" as to embrace Beethoven as a favorite.) Probably 95 per cent of all physicists are addicted to classical music and many are musicians themselves. Art criticism among circles of physicists and their wives is perhaps as sophisticated as one finds anywhere in the United States.

The chemists are also inclined to the classics, at least one might say that the majority express these preferences, but chemists want more melody and color and less counterpoint. When chemists congregate one is more likely to hear Brahms, Tchaikowsky (when Tchaikowsky is in vogue), Enescu, or Ferde Grafe. In their music, their artistic sensibilities, and their tastes in home decoration they are definitely "middle-brow," but this range is broad and inclusive since it brings together everyone from *Collier's* readers to *New Yorker* enthusiasts (where a merging occurs with the "highbrows").



The engineers can hardly be classified in this manner because engineers try to accommodate themselves to their surroundings. If they live and work with fundamental scientists they will gradually come to like Gershwin and Offenbach and not be completely bored by Beethoven. In the metropolitan areas, where engineers associate more with their own kind, they take to stage musicals and may also specialize in classics of jazz, swing, or bop. In heavily industrial areas you will find their enthusiasm in sports undimmed and over-riding—but, strangely, the best minds among them reserve an hour a week or so for some private effort, such as modern poetry, ancient history, or the anthropology of exotic places, a diversion which seems to release some of the pressures under which they work professionally.

It is interesting to note how exceptional the New York City environment has been in the differentiation of esthetic preferences. Those scientists and engineers who grew up in New York had little more chance of finding a high level of esthetic appreciation at home than those in the rest of the United States, but since New York was *the* cultural center, culture was always close to home and provided an early challenge to the intellect and imagination. In New York, most bright youngsters developed preferences for symphonies and opera, irrespective of profession. One notes this same equalization of tastes regardless of class origin in the San Francisco area, but to a lesser extent.

For the vast majority of scientists, the esthetic sensibilities were already molded by the time they entered college, and since then there has been only minor adaptation, just as the foundations for their political orientations had also already been laid.

THE DRIFTERS AND HYBRIDS

Generalizations about human society can never be perfect, so one is continually running into instances of careers which fall athwart the neatly defined categories. The supreme accomplishment then is to find new generalizations which apply to virtually all exceptions.

The scientists who changed their minds are a most fascinating study. The "drifter" may be defined as a person who came to realize that he had chosen an unsuitable profession while still obtaining his training. These men found, to their inner consternation, that there were fields more intellectually exciting than their own. America's cafeteria-style education system made it quite possible to salvage most of the effort already invested, so the change of direction was not a formidable undertaking. By this process the armchair sciences, such as theoretical chemistry, physics, and mathematics were greatly enriched from the ranks of the engineers and the applied science areas. There were much larger numbers of incompetents and dilettantes also drifting at the time, but very few of them are identified as scientists today; therefore they can be excluded from this discussion.

The drifters were outstanding among youngsters who were all exceptionally able. They found it easy to discover the standards of behavior in the new profession and adjusted without great difficulty; however, one could always note a more practical bent in

their line of theorizing than was common among their colleagues.

The hybrid scientist is a somewhat rarer phenomenon; he is the full-fledged professional who decided that the problems were more vital in some area for which he had no training whatsoever. Crossing over at this late stage takes fortitude because the more solid members of the profession he has been in and those in the new area will mutually cluck their tongues at his brashness. Yet there have now been so many instances in which crossing over has been accomplished successfully that the research councils and foundations have been setting up funds and programs to encourage still more of this sort of thing. Thus physicists may move into metallurgy or meteorology, engineers into psychology, and biology is fair game for everyone. Even the social sciences are receiving a few. The contributions of the hybrids are very rapidly bringing about a unification of the conceptual framework of the various scientific disciplines.

There is one highly successful generalization that can be made about the hybrid scientist. Almost without exception he crosses over from a more precise subject matter to a new area which is less precise in its data-gathering and experimental techniques. The hybrid is usually impelled to do this because his curiosity is stronger than the set of behavior patterns communicated to him as characteristic of his specialty. He is problem-oriented and, when the solution to the problem takes him to the boundary of his established competence, he refuses to be intimidated. Armed with the concepts and techniques he has learned and the special insights he has personally deduced, he will vault the barrier—if the new subject matter is more diffuse and qualitative.

Here is encountered a phenomenon among scientists which is often subconscious, occasionally recognized in part, but seldom understood for what it is—a consistent deference to theorists and the wielders of abstraction. The men who fit symbols to the data, or vice versa, generally have the last word. Thus an informal hierarchy of intellect has been created in the scientific community which finds the theoretical physicists, the geneticists, and the mathematical statisticians at the top of the peck order and the ordinary engineers and medicos at the bottom. Therefore a feeling of intellectual superiority reinforces one's confidence in himself if he crosses over into a less organized field of endeavor, but this is missing if the problem were pursued into a more theoretical discipline. In the latter instance the curious scientist will try to establish a cooperative arrangement with some sympathetic specialist rather than educate himself to meet those higher standards of criticism and manipulation of symbols.

THEIR MORAL CODES

The personal ethos for every person is a product of his social origins as modified by his adult experience. Problems of ethics are much more severe if the individual no longer circulates in the kind of society to which he became accustomed as a child.

Most chemists, engineers, and many biologists have ascended in social status and so have had to learn, in later life, how to behave in new and relatively strange surroundings. As one would expect, the adaptation was usually not complete, a high degree of sophistication in the new role was seldom achieved, and elaborate "holeproof" analyses of right versus wrong were rare. The engineers, because in general they have moved farther up the social scale and have had the least booklearning in cultural subjects, tend to exhibit responsibility only toward their families, their employers, and a close circle of suburban or metropolitan friends. The chemists will go farther and usually become responsible participants in the community, while a large proportion of the physicists struggle to define their responsibilities in terms of ultimates such as Truth, the liberal viewpoint, or the democratic concept. The attitudes of biologists are so diverse it is best not to generalize.

Scientists are bedeviled because two codes of behavior are demanded of them, and society requires that these be kept separate. In the laboratory and design office an attempt is made to exclude emotional bias and moral standards (mainly because experience tells us they lead to errors in logic and fact-finding), while in the remainder of daily life a rigorous scientific outlook is quite reprehensible. The mark of the successful scientist is that he has disciplined himself to compartmentalize his life so that neither side will seriously influence the other. It is not surprising then that many have developed schizoid personalities and that they suffer from the mental strain that is thereby induced.

The scientist's ethical troubles come to a head when his work takes on a recognizable social purpose. The results and consequences of one's own scientific work are obscured as long as the individual's effort is a highly specialized contribution to knowledge or technological advance. When the consequences of the search for truth are essentially unpredictable, the ethics of the investigators are limited mainly to their dealings with each other. In recent years, however, large and effective research organizations have been put together whose primary purpose (such as, for instance, weapons development) may conflict with the ideals maintained in the "social compartment" of the scientist's life. The most sensitive, of course, do not take risks with their consciences and refuse to join up, but the letting of research and design contracts to existing industrial organizations and academic research institutes means that the issue can be brought right to the scientist in his own laboratory. He must either accede or move out. Knowledge of this destructive aim seldom perturbs the engineer, since cause-and-effect relationships in society and international relations are extremely vague to him. Most of the chemists can effect the compromise without visible qualms, but the physicists are made very uneasy. The later build up highly elaborated rationalizations to justify what they do but are obviously not confident of the logical validity of their alibi.

The dilemma of what to do about the uses to which their findings are put confronts all the scientific species today, but each approaches the issue in a different manner. The engineer does not take the trouble to comprehend it, the chemist is more likely to be the "realist," explaining he couldn't do much about it unless chemists were the rulers, while the physicist sulks and worries, occasionally bursting into a protest. Few biologists have been personally affected as yet (the fraction

involved in biological warfare was very small) because their efforts are directed to the betterment of health and the improvement of agriculture—goals which can still be both practical and idealistic. The fact that only biology offers the same ideals that all science did in H. G. Wells' time is another important reason (operating at the sub-conscious level) for the current drift of the best scientific minds into biological subjects.

The differences in background among the scientific species leads to conflicting viewpoints in their national societies and even greater ones in their regional organizations. Scientific groups drawn upon professional lines cannot agree upon what a scientist's duty should be. The coming generation, however, will start from quite different social premises and may actually be able to effect a compromise between these two disparate worlds.

THE FORTHCOMING GENERATION

The present students view a scientific career as the path to prestige and security, rather than the road to romance and the power to control the environment. The new generation doesn't care to "set the world on fire." Like fire, they see science and engineering as double-edged occupations which may result in either good or evil. They hope to earn a decent income with intellectual effort and to live out a normal existence; they expect trouble but do not intend to be responsible for stirring it up.

Many students have grasped from their teachers, after spending some time in the departments, that the fun has gone out of physics, and that chemistry has lost its romance. This is reflected in the reduced numbers of students intending to continue in chemistry, since the proportion is much smaller now than before the war. The number of good minds enrolling is even more reduced, and this is just now showing up in the new crop being brought into the graduate schools—the chemistry professors are going to have a hard time getting adjusted to the level of mediocrity which other departments have always had to put up with. There was a post-war expansion in the physics schools, but the attractive power of nuclear studies has already diminished and, in spite of the abnormally high salaries beckoning in the AEC, appears to be declining.

Biology has glamor for the youngsters too, and the amount of drifting in that direction is considerable. Those with chemical training are intrigued by problems in the prevention of disease and the even more complex processes of aging, while those with background in physics are interested in reproduction or in the nervous system.

Up till now the social studies have remained virtually unaffected by the flux in the scientific professions, but their isolation is likely to come to an end in the near future. Already there are isolated examples of invasion from the physical sciences, and an interesting post-war phenomenon in many American graduate schools was the application of a few physicists and chemists to study for degrees in international relations, economics, social psychology, etc.

Today's novices are somewhat less ignorant of science and engineering than their predecessors at the time of decision, since they are often influenced by relatives or family friends who have had scientific experience. However the most important rationalizing element in their choice of profession is the counselling service. Veterans, in particular, were handed free, and supposedly expert, advice on virtually every campus. These choices were affected much less by adolescent dreams and relatively little by experiences while in the service (except for engineering, which attracted many young men who would not have gotten to college at all if it were not for the provisions of the G.I. Bill) but based mainly upon their individual capacities as demonstrated by scores on aptitude tests.[3]

There is another major step that needs to be taken before the selection of students for scientific training becomes fully "scientific." It is a procedure for adjusting the supply of each species to fit the predicted demand. In Great Britain, for instance, there is a consistent tendency to select and train at least three times too many geologists and architects and far too few chemical engineers.[4] Both Tories and Fabians are inclined to favor the intervention of the state so that the supply more nearly conforms to the demand. Presumably this would mean creating greater inducements for the study of such subjects as chemical engineering, or it could mean that the crossing over from such subjects as physical chemistry, metallurgy, and mathematics would be encouraged. Because of unanticipated changes in society's need for the respective scientific species, it seems best to overload the curriculum with the more theoretical subjects because the "law" formulated earlier regarding the creation of hybrids holds almost as universally in Europe as in the United States. Thus, by utilizing the crossing-over phenomenon, it is possible to provide for a considerable safety factor, which would be valuable for the survival of a society if it were to face an emergency of five to ten years duration or more.

The use of psychological tests to sort out scientific talent means that the class bias distinguishing the species will gradually disappear. The social outlook will also change, but in directions which are still indeterminate. Perhaps fully rationalized behavior may obtain a release from its imprisonment in the laboratory, infiltrate the character-building going on in the schools and some of the homes, and a variety of scientific humanism may be the keynote of the subsequent generations. On the other hand, the requirements of a strict ultra-loyalty, demands for conforming in both thought and deed, and the continuous intrusion of the political sphere will make of all the science a routine performance of superior skills. Theoretically, either of these alternatives would alleviate the discomfort of the schizoid pattern of behavior which is now required for scientific success.

[3] In many ways these developments parallel recent trends in British and some Continental university systems. There a predominant proportion (70–90 per cent) of the students have middle class origins so that fear or failure, and therefore loss of social status drive almost all of them to choose the safest areas for specialization, i.e., the ones in which their entrance exams were rated the highest. In these countries all the scientific professions are so thoroughly middle class in outlook that the minority which filters up from the lower strata have to assume quite completely the customs and idiosyncrasies of the middle classes. Differences in attitudes among the scientific species are largely limited to the intellectual hierarchy described earlier, but modified locally by long-standing traditions.

[4] The underlying causes and possible cures for this situation are discussed in my paper "Research as a Social Process," *British Journal of Sociology*, 1951 (in press).

NEW HORIZONS FOR INDUSTRY IN THE ISOTOPES FIELD

T. KEITH GLENNAN

In this article Dr. Glennan, a member of the U.S. Atomic Energy Commission, discusses progress in isotope research and the feasibility of transferring isotope production from government control to private enterprise. Dr. Glennan is on leave as President of Case Institute of Technology.

ISOTOPES for scientific, medical, agricultural, and industrial use constitute by far the most important contribution of the development of atomic energy to peacetime welfare. Industrial power from nuclear sources will unquestionably be produced on a large scale at some future date, and there may well be many other potential benign uses for atomic energy which have not yet been visualized. But isotopes are already at work in hundreds of places, both in this country and abroad, adding to man's knowledge of the still largely mysterious natural forces around him and contributing tangibly and importantly to his welfare.

As useful as isotopes are already beginning to be, we have hardly yet begun to scratch the surface so far as realizing their ultimate potentialities. We have a very long way to go, but it is encouraging to reflect, also, on how far, actually, we have come in the short space of time we have had access to isotopes in quantity.

The most important single limiting factor in the utilization of isotopes has been the relatively small number of people who know how to use them safely and effectively. Much of the credit for the progress made to date must go to the Atomic Energy Commission's Isotope Division at Oak Ridge, to the AEC Fellowship Program, and to the Oak Ridge Institute of Nuclear Studies which up to the present has trained over seven hundred people from industry, medicine, and agriculture in its radioisotope training courses. An increasingly large share of the credit should also go to our colleges and universities for sponsoring conferences and for including courses in isotopic technique in their medical and scientific curricula.

As evidence of the progress that has been made I would like to point to some rather significant figures. In 1947, 241 departments in 160 institutions were using isotopes. Two years later, in August 1949, there were 549 departments in 305 institutions using isotopes. And in December 1950, the Atomic Energy Commission reported in its semiannual report to Congress that AEC-supplied isotopes were in use in 939 departments of 485 institutions in 47 states and territories of the United States and 175 institutions in 29 nations abroad.

DEVELOPMENT AND GROWTH OF ISOTOPE RESEARCH

To begin with, let us examine briefly just how we got where we are today in the isotope field. This is of course a long and complicated story, but there are some high spots that are certainly worthy of particular mention. One of the first of these occurred as long ago as 1907, when two researchers named McCoy and Ross at the University of Chicago showed for the first time that two different radioelements—thorium and radiothorium—might be identical chemically. With this as a beginning, nearly forty species of elements occupying but twelve places in the periodic table were identified by 1911. It was apparent from this that in some cases, at least, several radioactive species would have to occupy the same position in the periodic chart.

Among the leaders in this research were McCoy and Boltwood in the United States, MarckWald in Germany, and Soddy in England. It was the Englishman Soddy who, in 1913, put forward the generalization that all elements falling into the same place in the periodic table are chemically identical and nonseparable by chemical methods. For these species of elements he proposed the name "isotope," which he took from the Greek words "iso," meaning "same," and "topos," meaning "place."

The discovery that radioactive isotopes could be useful instruments in research was made very closely on the heels of the discovery that there were such things as isotopes. The first to demonstrate this were the German scientists Hevesy and Paneth who, in the same year that isotopes were discovered, showed that minute amounts of the naturally-occurring isotope Radium D could be used as a radioactive tracer, or "indicator," as they called it, for determining the solubilities of certain lead salts. Five years later, in 1918, Paneth reported that he had again found naturally-occurring radioisotopes useful, this time to study the behavior of the unstable hydrides of lead and bismuth.

While this research with naturally-occurring radioisotopes was going on, another parallel development necessary for future progress in the isotope field was taking place in the laboratory of the great English physicist, Rutherford, who was studying the possibility of transmuting one atom into another through bombardment with radioactive particles from natural sources. This was a necessary step in the development of the isotope field because naturally-occurring radioisotopes are relatively few in number and severely limited in their application. Rutherford had first postulated his theory that the properties of atomic nuclei could be changed by bombardment with atomic particles in 1914 in a paper

An address given on April 5 at Conference on Radioisotopes in Industry, Case Institute of Technology, Cleveland, Ohio.

read in Washington, D.C., during a visit to this country. He actually accomplished this in 1919, in his laboratory in England, when he produced charged particles of hydrogen by bombardment of nitrogen with alpha particles from a natural source. The utilization of radioisotopes to any appreciable extent had to wait many years, however, for the development of more effective means of producing them. Although the fact that isotopes could be created through nuclear bombardment had been proved, the number and variety of isotopes that could be produced with alpha particles from natural sources was actually very small.

IMPORTANT ADVANCES

The next important development in the history of isotopes took place in 1928 in the United States when the theoretical physicist, Gamow, calculated that other particles than alphas would be more effective in causing nuclear transformations. This conclusion by an outstanding scientist aroused interest throughout the world and stimulated research into the possibility of producing protons of sufficiently high energies to affect the nuclei of atoms. Again it was in the laboratory of the English physicist, Rutherford, that an important theoretical calculation was proved when, in 1932, two of Rutherford's assistants—Cockcroft and Walton—obtained protons by ionization of hydrogen in a discharge tube, accelerated them to high enough energies to be useful by means of high voltages, and used them to bombard lithium to produce helium. This important experiment marked the first time that nuclear transformations had been brought about by purely artificial means, and opened up a line of development that has led to the Van de Graaff generators, cyclotrons, synchrotons, betatrons, and the other great machines which were the sole source for many years of the isotopes used for research purposes and which we still use today for—among other things—the production of certain isotopes not readily available from nuclear reactor operations.

There is one more important milestone in the history of isotope development which I would like to mention before we look into the situation as it is today. This took place in 1935 when artificially-produced radioisotopes were used for the first time in a research experiment. This was done by Hevesy in Germany when he used radiophosphorus as a tracer in a study of the absorption by plants of phosphorus from a nutrient solution. With this as a beginning, the decade from 1935 to 1945 saw the publication of several hundred reports on the use of artificially-produced isotopes for the study of problems in a number of different scientific and industrial fields.

In looking back over the history of development in the isotope field up to the inception of the U.S. atomic energy program several clear facts emerge: (1) it was international in character, (2) it was on a small laboratory scale rather than a large production scale, and (3) it was outside the area of interest or control of government.

EFFECT OF ATOMIC ENERGY PROGRAM ON ISOTOPE DEVELOPMENT

Now let us examine for a moment what effect the establishment of the U.S. atomic energy program had upon isotope development. The principal effect, of course, was the development of the nuclear reactor, a machine in which radioisotopes can be produced in quantities and varieties never imagined in the days of Soddy and Rutherford. This has unquestionably been the outstanding contribution of the atomic energy program to progress in the utilization of isotopes. It has made isotopes cheap and plentiful, and has served to reverse completely the situation which existed before World War II when there were fewer materials available than there were people to use them. Today, in contrast, the supply of isotopes far outruns the supply of people who are skilled in their utilization.

This availability of radioisotopes in quantity has in turn had some very definite effects upon isotope development. It has, for example, resulted not only in their increased utilization, but also in the growth of brand new subsidiary industries, such as the radiation detection instrument industry, which now does about eight million dollars worth of business a year, and of an as yet relatively small industry which synthesizes isotopic compounds and provides supplies and services to isotope users.

NECESSARY GOVERNMENT INTRUSION IN ISOTOPES FIELD

The establishment of the national atomic energy program has also had another profound effect upon isotope development, and that is the intrusion of government into a field which had hitherto been the private domain of science. In a sense, the presence of government in the isotope business is artificial, for it is not there because isotopes are secret or need to be controlled for security reasons, but rather because it is virtually the only source of supply. And it is virtually the only source of supply for a reason quite unrelated to isotope utilization, and that is the fact that the vast majority of isotopes are produced in nuclear reactors which contain fissionable materials that can also be used in weapons.

This presence of government in the isotope business has not, I feel, been wholly bad. As a matter of fact I believe it has been to the good. I say this because, as you know, the vast majority of the isotopes produced in this country are produced in the nuclear reactor at Oak Ridge. This reactor was not built for the purpose of producing isotopes, and it was not built by people who had in mind amortizing its cost through the sale of isotopes. It was built, instead, as a pilot plant for the plutonium production reactors at Hanford, and its cost was written off as an item contributing to the development of the atomic bomb. Pretty much the same thing can also be said of the other great machines which are today contributing to our isotope supply, such as the reactors at Brookhaven and Chicago and the particle accelerators in various parts of the country—they were all built for another purpose and produce isotopes as a bonus by-product. For this reason, the price the industrial purchaser pays for isotopes today is set to cover the cost of production, but the cost of building the machines is not passed on to him. Yes, the term subsidization raises its ugly head but in this case no one can quarrel with the values being derived.

In contrast to many of its activities the government's handling of the isotope business has been good, both under the Manhattan Engineer District, which began distribution of isotopes to off-project users in 1946, and under the Atomic Energy Commission. Under this program, about all a potential buyer has to show is that he knows how to use isotopes productively and safely. Oh yes—he may be required to report the status of his work from time to time, but if he is an industrial user these reports are handled confidentially, except with his permission to do otherwise, to protect his patent rights and competitive position. In other words, as far as controls are concerned, the government is trying to

remain as unobtrusive as possible while isotopes find their rightful place in the main stream of U.S. economy.

Beyond this, the government also has a program for stimulating the utilization of isotopes by providing, on request, information on isotopes, instruction to potential buyers on how to use them productively and safely, and assistance in the design and arrangement of suitable facilities. The government is also trying to preserve the free, open, and international character of isotope development by permitting uncensored publication of results by users who have not had access to any of the secret data of the atomic energy program.

To sum up, what we have then today is a situation where: (1) unlike the pre-war days, isotopes are available in great quantities; (2) purely for reasons unrelated to the isotopes themselves, the government has a virtual monopoly in their production and sale; (3) the government subsidizes isotope production to a large extent by charging only enough to cover the cost of production and handling; and (4) the government provides special services to isotope users at cost or less in order to stimulate isotope utilization.

I think we can all agree that under the government's stewardship, the progress in the nation's isotope business has been impressive and continues to be so. But the questions naturally arise: Where do we go from here? Should the government continue to hold its monopoly in this field? What are the responsibilities and opportunities of science and industry in the future?

Before getting into this too deeply I would like to first state that it is the ultimate objective of the Atomic Energy Commission to work itself out of the isotope business. As long as there is no effective international control of atomic energy, the government must, of course, retain control over machines that use or can be utilized to produce fissionable materials, but there is no reason to believe that the government must always own and operate every one of them.

In this connection, I should like to refer to the Declaration of Policy of the Atomic Energy Act of 1946, the law which set up the Atomic Energy Commission and which established the national atomic energy program as it is now operated. This Act states:

"It is hereby declared to be the policy of the people of the United States that, subject at all times to the paramount objective of assuring the common defense and security, the development and utilization of atomic energy shall, so far as practicable, be directed toward improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace."

The isotope program, as it is administered today, is almost uniquely—among atomic energy enterprises—directed toward the objectives listed in the latter part of this statement. As a matter of fact it is this Declaration of Policy which has determined to a large extent the character of this program and the direction it has taken. But the day will inevitably come, as more people in industry learn more about the isotope business, when the objectives of this policy will be better served through a retrenchment of government activities and an enlargement of industry's.

EXPECTED TRANSFER TO PRIVATE ENTERPRISE

It is toward this day that industry must begin to look. I do not mean by this that we will necessarily find ourselves in this position soon—we may well be many years away. In fact, it is my personal belief that the change in the character of the isotope program from a dominantly government to a dominantly private enterprise will and should come very gradually and in stages. We might say, in a sense, that this metamorphosis has already begun to take place. I might cite a few examples:

1. If you are in the market for isotopes synthesized into compounds that are not available from the Atomic Energy Commission, you may be able to obtain them today from any one of five different private companies. To do this you will need the approval of the Atomic Energy Commission, and the isotopes in the compounds you buy will have come originally from the commission, but nevertheless it is interesting and significant that here we have private industry playing a role in the isotope business that is not played by the government.

2. Six months ago the AEC agreed to lend sufficient fissionable material to the North Carolina State College to enable that institution to build at its own expense a low-powered nuclear reactor. This reactor, which will be the first non-AEC reactor to be built in this country, will be used mainly for research and instruction in nuclear technology, but it will also be able to produce certain radioisotopes.

3. On April 4 the AEC announced that it had started discussions with the Bendix Aviation Corporation on a proposal by the company to undertake a privately financed feasibility study of a nuclear reactor to produce radioisotopes on a commercial basis. This action was in line with the commission's policy of undertaking cooperative studies with industrial concerns to explore the possibilities for their participation—on their own initiative and using their own resources—in the development of commercial applications of atomic energy. Several other such studies for other purposes are also being undertaken. The principal condition which the commission attaches to its cooperation in these studies in this emergency period is that the work must serve to enhance rather than to interfere with the atomic energy production program.

4. The commission now has before it several proposals by industrial concerns for permission to obtain radioactive fission products from the government for the purpose of performing research into their possible uses to industry if made available in quantity.

These, along with many other developments, are evidences of industry's gradually awakening interest in isotopes as something whose value can be measured not only in intangible research results but also in dollars and cents.

PREREQUISITES TO PRIVATE CONTROL OF ISOTOPE PROGRAM

So impressive has been our recent progress in the isotope field that I feel we have reached the point where we might properly examine a few of the obvious things that are needed if the participation of private enterprise is to continue to increase to the point where it might someday expect to take over a substantial share of the isotope program from government. By raising these points I do not mean that something necessarily needs to be done about them now, but I do think we might properly begin to think about them now. I shall list just a few:

1. The obvious need for vastly greater numbers of people trained in the techniques of handling and using isotopes. The government is now doing a fairly good job in accomplishing this, but if isotopes are ever to take

(*Continued on page 191*)

PROGRESS AND ACTIVITIES IN MAJOR ATOMIC ENERGY PROGRAMS IN 1950

NINTH SEMIANNUAL REPORT OF THE USAEC: PART ONE

The Bulletin has regularly published condensations of the half-yearly reports which the Atomic Energy Commission submits to Congress. Part One of the most recent report has been condensed by Dr. Anthony Turkevich, Associate Professor at the Institute for Nuclear Studies, University of Chicago. Part Two, covering AEC contract policy and operations, will be summarized in our next issue.

Condensed by
ANTHONY TURKEVICH

MUCH of the detailed developments of the new AEC programs cannot be discussed in an open report. The magnitude of the effort placed primarily in these directions is indicated, however, by two supplemental appropriations totaling 1.325 billion dollars, already approved by Congress for the fiscal year 1951.

Besides these financial signs, on November 28, 1950, the commission announced plans for construction on a 200,000-acre tract in Aiken and Barnwell Counties, S.C., of new facilities, to be designed, built, and operated for AEC by E. I. du Pont de Nemours & Co., wartime builders and operators of the Hanford, Washington, Engineer Works.

In a second announcement, December 15, 1950, the commission disclosed that part of the new funds would be used for a new facility to produce uranium 235 by the gaseous diffusion process employed at Oak Ridge—the plant to stand on a 5,000-acre site, including the 1,400 acres now comprising the Kentucky Ordnance Works, 16 miles west of Paducah, Ky.

Present indications suggest that construction of the Kentucky project will involve a peak force of 10,000 on construction and an ultimate operating force of 1,600. Union Carbide and Carbon Corp., contractor for the production and research facilities at Oak Ridge, Tenn., will operate the plant, and is responsible for process design and procurement of special and critical equipment and materials.

MILITARY PROGRESS

The Atomic Energy Commission reports continued progress during 1950 in the development of military phases.

Preparations for additional full-scale weapons tests continued in close coordination with the armed forces. The Eniwetok Proving Ground in the Marshall Islands will continue to be used. In addition, the Atomic Energy Commission has been authorized by the President to use a part of the 5,000-square-mile Las Vegas, Nevada, Bombing and Gunnery Range for experiments.

The accelerated tempo of this phase of the program is indicated in that the Las Vegas Bombing Range has at this writing already been used in publicly anounced tests of atomic weapons.[1]

REACTOR DEVELOPMENT

In recent years the commission has often been criticized for failure to push an aggressive program of reactor development. There are hints here that this aspect of the program is not being neglected.

At the Reactor Testing Station in Idaho, an experimental breeder reactor is being constructed, which will test the feasibility of creating new nuclear fuel faster than it is consumed and will produce a small amount of power for experimental purposes.

The reactor itself is being fabricated at the Argonne National Laboratory, where it was designed. It will operate in the high-energy neutron range.

Construction has been started at the testing station on two other reactors—the materials testing reactor and the land-based submarine thermal reactor. The materials testing reactor will operate in the thermal, or slow neutron, energy range. It will supply scientists with a much needed tool to test materials under intense neutron bombardment. Although the submarine thermal reactor is for the navy, it is giving impetus to the ultimate use of nuclear energy for industrial power production.

The objective of a third reactor program, that at the Knolls Atomic Power Laboratory operated by General Electric, was redirected toward the development of another type of submarine reactor power plant for the navy. This reactor will operate in a neutron energy range intermediate between thermal, or slow, neutrons and high energy neutrons.

The Atomic Energy Commission has also increased its participation in the study of the use of nuclear energy for aircraft propulsion.

The construction of a chemical processing plant was started at the Reactor Testing Station in Idaho. It is hoped that operating data will show that future plants can be built safely in populated areas where power reactors may be required.

All the reactors that have been built so far, except the Los Alamos water boiler, are heterogeneous, that is, the fuel and moderator are separate, and in most reactors both are solids. There are possible advantages in homogeneous reactor assembly, such as a solution of a uranium or plutonium salt in water. The commission is beginning to give increased attention to such homogeneous reactors. The Oak Ridge National Laboratory has begun a pilot model of a fluid reactor as part of a long-range program in this field.

BROADENING OF THE PROGRAM

Besides the above-mentioned concrete advances, there were three landmarks during 1950 in the program to disseminate knowledge about nuclear

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AEC Contract Policy and Operations. Prepared by United States Atomic Energy Commission. Washington: U.S. Government Printing Office, January 1951. Pp. 158. $0.40.

[1] Other tests were carried out at Eniwetok Proving Grounds early in May.

reactors to a wider group of people than those closely associated with the Atomic Energy Commission.

In the first place, the commission approved the construction of a small reactor by a non-commission laboratory at the University of North Carolina. This will be a five kilowatt water boiler type of reactor, patterned on the Los Alamos reactor. It will be financed by the university for about $150,000 and will be located on the campus.

The commission has approved the loan of a maximum of 1 kilogram of U-235 required as fuel for the reactor, contingent upon final approval of safety and security plans. The reactor will be completely unclassified, but the uranium fuel will be guarded.

A curriculum in reactor engineering has been established at the North Carolina State College, and the reactor will be used for unclassified research. The university will be able to produce radioisotopes for use within the Greater University of North Carolina and for other institutions in the area.

A second landmark was a significant increase in the amount of information declassified pertaining to low-power research reactors. This now includes data on the thermal neutron cross-sections of uranium (including the existence of and the cross-section for slow neutron capture by U-235), the number of neutrons emitted in the thermal neutron fission of U-235, data on the energy distribution of prompt neutrons resulting from thermal neutron fission of U-235, and other nuclear properties of uranium of importance to the design and operation of low-power research reactors.

Finally, the commission welcomed during 1950 several inquiries from private industry, expressing interest in financing reactors for producing both power and plutonium. It is studying the problems involved.

PHYSICAL RESEARCH

The Division of Research allocated over 23 million dollars to the support of basic research for the year 1950–51, two-thirds devoted to basic research in AEC laboratories and one-third to contracts with universities and private research institutions. In the latter category, 2.7 million went into contracts administered through a joint program with the Office of Naval Research. Other research supported under the physical research program—applied research and development—was allotted 8.1 million.

A significant part of the commission's research effort is the construction of new machines for nuclear research.

The commission announced that modification of the Brookhaven National Laboratory research reactor was completed on August 11, 1950, and by August 22 the reactor had been loaded to criticality. Several months of tests will precede routine operation at its designed power level. Operators are studying the effect on the behavior of the pile of a variety of factors such as atmospheric pressures, temperature, the specific pattern in which uranium is loaded into the reactor, and the temperature of the reactor.

The AEC supported during the year, both directly and through a joint program with the Office of Naval Research, a program for constructing and operating several powerful particle accelerators. These important tools for studying nuclear forces and structure will produce elementary particles of several types with energies ranging from 300 million electron volts (mev) to several billion electron volts (bev).

The most powerful of these, the bevatron at University of California Radiation Laboratory, will produce protons with energies between 6 and 7 billion electron volts. Construction is scheduled to be finished in December 1953. A similar machine, a "cosmotron" nearing completion at Brookhaven National Laboratory, is designed to produce protons with energies of about 2.5 Bev.

Two other very powerful machines under construction in 1950 will produce electrons with energies of one billion electron volts. A synchrotron, being constructed at California Institute of Technology, is to be completed by 1953, and an electron linear accelerator, being supported jointly by AEC and ONR at Stanford University, is scheduled for completion in 1952. Low-energy electrons are being produced in the Stanford machine now.

The first of several proton accelerators operating in the 250 to 500 Mev range to be constructed since the war was completed at Columbia University in May. It is designed to produce 450 Mev protons. Similar machines are nearing completion at the University of Chicago and the Carnegie Institute of Technology, and a slightly smaller one was completed at the University of Rochester in late 1948. These four accelerators have been jointly financed by the AEC and the ONR. In addition the joint program is sponsoring five other accelerators to produce 300 Mev electrons.

FELLOWSHIP PROGRAM

The Oak Ridge Institute of Nuclear Studies agreed late this year to administer the entire fellowship program for the academic year 1951–52 on a national basis, subject to the negotiation of an appropriate contract. The program will continue at the following levels in 1951:

New appointments in predoctoral physical sciences, 150; new appointments in predoctoral biological sciences, 100; new appointments in postdoctoral physical sciences, 30; new appointments in postdoctoral biological sciences (including medicine and agriculture), 45.

The Oak Ridge Institute of Nuclear Studies will also consider requests for reappointment. The National Research Council will continue to assess the scientific qualifications of applicants and to advise the Oak Ridge Institute of Nuclear Studies on administering the program.

RESULTS IN RESEARCH

Discovery of new elements.—During 1950 the University of California Radiation Laboratory at Berkeley announced the discovery of two new transuranic elements. These elements, numbers 97 and 98, extend the series of known elements by two, making the list now comprise six beyond uranium, number 92, the heaviest element known before the United States atomic energy project began.

The isotope of element 97, berkelium, was prepared by bombardment of americium 291 with 35 Mev helium ions in the 60-inch cyclotron. Its mass number is 243. Its radioactive decay proceeds predominately by electron capture with a half-life of 4.8 hours.

The other element, No. 98, named californium by its discoverers, has a mass of 244. It was made by alpha bombardment of curium in the 60-inch cyclotron and purification in an ion-exchange column. The new element emits alpha particles with an energy of 7.2 Mev and has a half-life of 45 minutes.

Acceleration of carbon nuclei in cyclotron.—During the past four years, efforts have been made at the University of California Radiation Laboratory to accelerate in the cyclotron heavy ions with masses of 10 to 19, such as boron, carbon, nitrogen, oxygen, and fluorine so that they can be used for bombarding other nuclei to produce

transuranic elements in quantity. Previously, the heaviest bombarding particle has been helium 4—the alpha particle.

Recently, detectable beams of carbon 12 and carbon 13 have been accelerated to energies of over 100 Mev in the 60-inch cyclotron. Gold 197, bombarded with carbon nuclei, produced astatine 205 in measurable quantities, an increase in mass of 8 units, while bombardments of aluminum 27 produced chlorine 34.

Fission of copper 63.—About a year ago it was discovered at the University of California Radiation Laboratory that chlorine 38 is found among the products of high-energy proton bombardments of copper 63, and the mechanism of formation was concluded to be fission rather than spallation.[2]

Since that time, studies have been made of similar reactions in other elements of intermediate atomic number, including bromine, silver, and gallium. Bombardments were carried out at increasing energies, and in all cases "fission" products were formed at bombardment energies below those at which the same products theoretically could be produced by spallation reactions.

Meson research.—The most fruitful attack on the problem of nuclear forces at the present time appears to be the study of the properties of mesons. The existence of these particles was postulated in 1935 by Hideki Yukawa, a Japanese physicist, in deriving a theory of nuclear forces; his theory gained support when similar particles were actually discovered in cosmic radiations. After completion of the 184-inch cyclotron it was possible to produce these particles in the laboratory and this greatly assisted the study of their properties.

During the last six months, the University of California Radiation Laboratory group has confirmed experimentally the existence of a predicted neutral heavy meson which disintegrates into two gamma rays. Determinations have been made of the masses, lifetimes, and mechanisms of formation and absorption of mesons.

APPROPRIATIONS FOR BIOLOGICAL AND MEDICAL RESEARCH

The AEC financed biological and medical research during 1950 at a rate of 22.1 million dollars a year, not including the outlay for new buildings and equipment. Approximately 85 per cent of this work was in the unclassified area. Of the 22.1 million, 1.4 million dollars went for research in cancer, 6.6 million for other medical research, 9.5 million for biological research, 3.6 million for biophysics research, 1 million for special training and fellowships.

Fifteen million of the total went for research work in AEC laboratories, production and other centers. The five-million total for contract research, 35 per cent above the previous year, was spent under some 250 research contracts with 76 universities and colleges and 20 hospitals, research laboratories, and other private institutions where 1,000 scientists and technicians worked on problems related to atomic energy. The Atomic Bomb Casualty Commission, working in Japan, received 1.7 million.

RESEARCH ON RADIATION EXPOSURES

Research on uranium has answered most of the important questions about its toxic and radioactive effects on people. AEC curtailed this research and put greater effort into studies on plutonium during 1950. Three years' work at present levels should bring knowledge about plutonium to the level of present knowledge about uranium.

Large-scale studies of biological damage by neutrons are under way at Argonne and Brookhaven. Using mice for experimental animals, Oak Ridge National Laboratory continued an investigation into the pathology of slow or low-energy neutrons, their effects on longevity, and their role in causing cancers and cataracts.

The Radiological Research Laboratory at Columbia University is seeking to correlate definite levels of exposure to radiation with specific biological effects. This correlation requires measuring exposure in terms of energy absorbed per gram of tissue, and effort has concentrated on developing apparatus and techniques to do this.

The Columbia group is also studying cataracts of the eye, induced by radiation. A number of physicists working with cyclotrons developed cataracts, and cataracts also have appeared with more than normal frequency in survivors at Hiroshima and Nagasaki.

On December 11, 1950, the AEC established the maximum permissible level for chronic exposure of the total body to penetrating radiation and set limits on permissible exposure to radiation of atomic energy personnel who may be called upon in emergency to cope with radiological disasters in war or peace. Emergency limits believed safe for contamination of food or drinking water were established. These standards were developed during the year on the basis of research, experience, and the consensus of expert judgment.

RESEARCH ON ATOMIC EXPLOSION INJURIES AND TREATMENT

Studies were under way in 1950 on three types of injury which may be caused by an atomic explosion—direct blast injury, flash burns, and radiation injury.

At the University of California, Los Angeles, apparatus was developed for simulating explosive blasts, by pumping air in a vessel to a predetermined pressure, and then releasing the pressure by suddenly shattering a membrane. The resulting pressure wave strikes small animals, usually mice. The blasts of predetermined force made possible give reliable data for analysis. Observations indicate that the effects are complex, and methods of physiological protection or of medical treatment so far are unknown. Since blast waves arise in every kind of explosion, these studies have implications extending beyond the field of atomic energy.

The University of Rochester recently developed a laboratory method of producing flash burns, a major cause of injury in atomic explosions, and is conducting research on methods of treating such burns. The effectiveness of ACTH and other agents in combating burns is under test.

Under sponsorship of the American National Red Cross, scientists at Harvard University undertook to develop methods of separating plasma from blood so as to build up a plasma stockpile for use in disasters. With AEC financing, Harvard worked out a successful method of separating white blood cells and platelets from blood processed at Red Cross blood centers. White cells separated in this manner live for about two weeks.

They can now be transfused without other components of blood and may prove to be of value in combating the infection that follows acute radiation injury, leukemia, and certain other disease conditions. Several AEC laboratories and investigators are to obtain supplies of white blood cells for such research.

[2] Spallation is a nuclear process in which a large fragment and a number of smaller fragments are produced.

During the past year, AEC-financed research continued the study of methods of minimizing radiation injuries or assisting recovery from their effects, and knowledge gained by experiment with animals suggests that it may be possible to develop methods which will enable human beings to survive radiation exposure which otherwise would prove fatal.

The project at the University of California at Los Angeles carried out basic studies on the effects of radiation and treatment of radiation injuries. Experiments dealt, for example, with the responses of blood vessels to various drugs after exposure to radiation, the effects of radiation on the ability of the intestines to absorb vitamins and amino acids, and the processes by which such metals as plutonium become deposited in bone and how they can be dislodged. AEC-financed investigators at the University of Chicago are preparing to bombard individual structures in single living cells with high-energy radiation in an effort to learn more about how radiation produces biological damage.

The Atomic Bomb Casualty Commission, financed by AEC and administered by the National Research Council, is continuing its studies of survivors at Hiroshima and Nagasaki. The purposes are to determine the development of delayed radiation injury, alterations in the immunity of the exposed population to disease, any changes in fertility that may develop, and change in growth rates, if any, among children, as well as the genetic changes, if any, in the children of the survivors.

CANCER RESEARCH

The AEC program for cancer research is carefully limited to supplement and assist the national program under many different auspices.

The 30-bed Oak Ridge Cancer Hospital was completed and the first patients were admitted in April 1950. This hospital is devoted exclusively to experimental treatment of patients with certain short-lived radioisotopes produced in the Oak Ridge nuclear reactor. Patients are selected by medical schools in the South.

Longer-lived radioisotopes for work with cancer are distributed free except for shipping charges to qualified research scientists and to hospitals. This free distribution for cancer work amounted to 3,250 shipments during 1950, or 52 per cent of the AEC's total of 6,200 domestic shipments to all isotope users.

Ten beds were set aside in the hospital at Brookhaven National Laboratory for cancer experiment. The hospital has studied a few patients suffering from thyroid cancers.

One task at Brookhaven is to design a safe, portable apparatus for separating iodine 132, which loses half its radioactivity in 24 hours, from tellerium 132, a fission product of nuclear reactors which decays into iodine 132. Brookhaven also will seek methods for separating calcium, iron, and astatine in a state of high radioactivity.

A third AEC-financed facility is the Argonne Cancer Hospital, now under construction on the University of Chicago campus. Among the other centers for cancer research are the University of California at Berkeley; the University of Kansas; Meharry Medical College, Nashville, Tennessee; Ohio State University; and the University of Minnesota.

The AEC supports additional medical research in government-owned laboratories and in a number of medical schools, hospitals, and research institutions across the country. The purpose here is to safeguard the health of atomic energy workers, to seek methods to reduce the human injury that attends atomic bombing or radiological disaster, and, more broadly, to find fruitful ways to use the unique tools of atomic energy in the diagnosis and treatment of disease.

AGRICULTURAL RESEARCH

The range of research studies of interest to agriculture include the use of radiotracers to study proper fertilizer placement in crop planting, basic research on the genetics of mold, the speed of transmission of plant nutrients from the roots to the leaves of a plant, effects of radiation on plant growth and on the heredity of plants and animals and the fundamental life processes—photosynthesis, the functions of vitamins and amino acids, and the role of trace mineral elements required by both plants and animals.

GENETICS

Two years ago the AEC commenced a large-scale genetic study involving thousands of mice. The necessary strains and numbers of mice have been developed and scientific data are beginning to be obtained.

Studies showed that abnormalities result from exposing mouse embryos to X-rays, and that types of abnormalities are influenced by the size of the X-ray dose and the stage of development in the embryo at the time of exposure. Evidence collected in the last few months showed that exposures as low as 25 to 50 roentgens may have genetic effects upon some physical characteristics in mice.

The high frequency of partial sterility in mice after radiation (apparently a result of chromosome aberrations) has been confirmed at Oak Ridge. Studies of the affected cells are in progress to determine the cause.

A pilot experiment indicated that it is feasible to carry through the projected large-scale study of radiation-induced mutations of specific genes in mice, and that the mouse is at least as sensitive as the fruit-fly to genetic damage from radiation, and may be ten times more sensitive. Methods for artificial insemination of mice have been perfected, a procedure that will permit direct radiation of spermatozoa with heavier doses than can be tolerated by the testes.

BIOLOGICAL RESEARCH

Each major AEC laboratory has a varied program of fundamental studies in biology.

Brookhaven, for example, is carrying out investigations in two broad fields: the effects of radiation and studies of metabolism in plants and animals with the use of radioactive isotopes as tracers.

Major biological studies at Oak Ridge National Laboratory included the effects of radiations on germ cells and on the rate of cell division; mutations of fungi and bacteria; tracer studies on metabolism; biochemistry of nuclei acids; and studies of mice including pathology and physiology and the genetic and developmental effects of radiation. The University of California Atomic Energy Project at Los Angeles studies the effects of radiation on various enzyme-sybstrate systems, metabolism of fats and fatty acids, and the mechanisms of radiation effects. Los Alamos Scientific Laboratory concentrated on the toxicology of transuranic elements and other materials encountered in the weapons research program. The Hanford plant maintained a broad program of biological research and surveys to make sure that its operations were not contaminating the environment. Scientists at the University of California's Radiation Laboratory pursued a number of studies in tracer biochemistry and organic chemistry, radiobiology, and physical biochemistry, making use of particle accelerators and radioactive tracers. Argonne Na-

tional Laboratory conducted an extensive program of classified research in biology.

In addition to studies in its own laboratories, the AEC financed some 85 biological investigations in nearly 60 universities and other institutions.

DISTRIBUTION AND USE OF RADIOISOTOPES

During the year 1950, the isotope distribution program, one of the AEC's major activities for peaceful uses of atomic energy, continued to increase. More than 6,000 shipments of radioactive isotopes were made from the production facilities at Oak Ridge National Laboratory. This year's total amounts to more than 40 per cent of the 15,000 shipments in all made since the program was initiated in 1946.

In 1947, 241 departments in 160 institutions were using isotopes; two years later when the AEC issued its report, "Isotopes–A Three-Year Summary of U.S. Distribution," there were 549 departments in 305 institutions. As of December 1950, AEC-supplied isotopes were in use in 939 departments of 485 institutions in 47 states and territories of the United States and in 175 institutions in 29 nations abroad.

Growth in isotope distribution and utilization stems mainly from an increase in the number of scientists and technical personnel experienced in using radioactive materials, aided by construction and operation of a new radioisotope processing area.[3] The new processing facilities made it possible to offer to isotope users a wider range of radiomaterials at reduced costs. The increase in number of persons who know how to use radioisotopes safely is shown by the 142 new institutions and 287 new departments allocated these materials in 1950.

As tracer atoms, radioisotopes have become a standard research tool in many laboratories. Radioisotopes also are used increasingly as sources of ionizing radiation, as for instance, beta-ray applicators for treating certain pathological conditions such as lesions of the eye, beta-ray thickness gages, radiocobalt for radiographic testing, and use of multi-curie sources of radiocobalt as substitutes for 1- and 2-million-volt X-ray machines in therapy is proposed as well as numerous radioisotope applications as outgrowths of research programs already in progress.

An increasing number of reports indicate that radiophosphorus for treating polycythemia vera, a disease in which the number of red blood cells increases enormously, and radioiodine for treating overactivity of the thyroid gland, are being accepted as treatments. One such report was based on a survey of five hundred cases.

A development recently reported is the use of a radiocobalt-nylon thread as radiation source for certain treatments. It was found that warm nylon tubing may be stretched to a small diameter with good tensile strength, thus forming a thread suitable for sewing into position with ordinary surgical techniques. Radioactive cobalt wire may then be inserted through this small nylon tubing to make a very versatile radiation source for treating tumors accessible for application on body surfaces or in body openings.

Several groups of investigators reported using radioactive iodine to treat certain cases of intractable heart disease. In a group of patients with angina pectoris and normally functioning thyroid glands, 60 per cent were relieved in varying degrees by comparatively small doses of radioactive iodine, which reduced the thyroid function.

The use of radiodiiodofluorescein, a dye containing radioactive iodine and emitting gamma rays, in detecting and locating brain tumors was extended in 1950. The method is based on the fact that when this radioactive dye is injected intravenously into a patient, the dye is taken up more rapidly by most types of tumor tissue than by normal brain tissue.

Radioisotopes have been used as tracer atoms in investigating many fundamental and intricate problems in the fields of fertilizers, plant growth, animal husbandry, horticulture, entomology, and cattle raising. The use of tracer atoms in fertilizers continued to be developed as a valuable test of soil fertility as well as of the efficiency of fertilizer application.

INDUSTRIAL APPLICATIONS

During the year, radioisotope tracer programs were initiated in more than a score of industrial research laboratories. Although numerous new industrial problems were tackled for the first time with radioisotopes, some of the most interesting developments in 1950 resulted from research programs started in earlier years.

One group culminated a series of laboratory tracer studies on wear and friction by road-testing the wear of radioactive piston rings in an automobile under various driving conditions. As a result, the company conducting the tests has now offered a new lubricating oil for retail sale.

Another application resulting from extensive laboratory and small-scale tests is the routine use of radioisotopes in an oil products pipeline to run from Salt Lake City, Utah, to Pasco, Washington. The pipeline is now in operation to Boise, Idaho. A wide variety of products is pumped through the line, including several different types and grades of gasoline, Diesel oil, and stove oil. Radioactive antimony is used to mark the boundaries between the various products.

A new industrial application is the use of radioactive strontium in studying the movement of preservatives in telephone poles. By using the radioisotope as part of the material used to impregnate the pole, investigators can accurately determine the amount of penetration by letting the impregnated radioactive material take its own picture on a photographic film.

SECURITY

Measures to protect the atomic energy enterprise's property from sabotage and to maintain the security of its secret information was strengthened during 1950.

In order to assess the vulnerability to sabotage and to institute all practical countermeasures, special antisabotage studies have been conducted at the most vital plants and laboratories. The studies have covered all sensitive points at which serious damage could be effected by determined

[3] Described and pictured in *Eighth Semiannual Report,* Superintendent of Documents, Washington 25, D.C. $0.55.

persons who might gain access despite the safeguards which have been set up.

FBI liaison agents have been familiarized with technical aspects of vital operations and materials to assist them in evaluating and investigating any evidence of possible subversive activity.

Under the terms of the Atomic Energy Act, which calls for prior FBI investigation and AEC evaluation of FBI findings on the loyalty, character, and associations of persons given access to restricted information and restricted areas, about 200,000 persons have been investigated between January 1947 and the end of 1950. The figure includes both persons being considered for employment or close association with the program and the entire staff taken over from the wartime Manhattan Engineer District. In some 2,300 of the 200,000 cases, AEC instituted further review to determine whether clearance should be granted; approximately 700 were granted clearance after additional investigation, interview, or formal hearing, and the remaining 1,600 either were denied clearance or resigned or terminated employment before a final determination by the AEC of their eligibility for clearance.

The right to appeal adverse recommendations, originally available only to persons already in the program such as those taken over from the MED, was opened on September 19, 1950, to applicants for AEC employment and to AEC contractors and licensees where access to restricted data is required.

When an FBI report causes clearance to be withheld, the affected person is given an opportunity to be heard and to have his case reviewed by a board at the place where he has applied for employment. This board makes a recommendation to the local manager, who, in turn, makes a recommendation to the AEC general manager. If the local manager has made an adverse recommendation, the person may appeal to the commission's Personnel Security Review Board, which re-examines the entire record, including any brief he may choose to file. The review board then makes a recommendation to the general manager, who makes the final determination for the commission to grant or withhold clearance.[4]

[4] The detailed regulations covering "Security Clearance Procedures" are given in an appendix to the Ninth Semiannual Report.

COUNCIL MEETING OF THE FEDERATION OF AMERICAN SCIENTISTS

The new council of the Federation of American Scientists met in Washington on April 28 and 29. The following excerpts from the "FAS Newsletter" of May 2 summarize the items of discussion which are of national interest.

THE vigor of youth has in large measure departed from the FAS. The world is in an early epoch of the atomic age, but it is not the atomic age for which we hoped.

Our accomplishments have not been negligible: Our efforts on national legislation have been justified by the McMahon Act and the record of the AEC. Our support of the National Science Foundation has been and will continue to be an important effort. Our assertions that there was no true defense against atomic attack, that we could expect no enduring monopoly, have now been vindicated. Our efforts on international control have assisted the U.S. government to present a progressive and farsighted policy to the United Nations. But the failure to reach international agreement and the progressive deterioration of the international scene have destroyed any sense of accomplishment we might otherwise have.

Just as the federation's membership is older, so the federation has aged. Whether it is to be regarded as a mature or a senescent organization depends more upon its actions in the future than in the past. There is around us no dearth of problems.

PROGRAM FOR FUTURE

As an organization of scientists, we will support and assist the National Science Foundation. As scientists we will present our views to agencies concerned with scientific manpower mobilization. As scientists we cannot help but deplore recent administrative changes in the loyalty program whereby reasonable doubt of a person's loyalty, whether or not his position has relation to the national security, is justification for his removal from public service.

In the field of civil defense, the federation can speak with special competence. The consensus of the council is that at present certain aspects of civil defense are not being handled in a manner which best serves the interests of the nation. A thorough analysis of present policy and organization is necessary before the federation can decide upon specific action.

The Chicago association has presented a new proposal with regard to international control, calling for the establishment of a board of consultants, much like the Lilienthal Board, to analyze the present situation in order that the United States know within what framework negotiations can be carried on. The Acheson-Lilienthal plan is history and can no longer be realistically proposed. At present, there is no published plan for general disarmament nor for the more limited problem of atomic armament limitation. The Chicago proposal has been referred to the local chapters and council delegates-at-large for suggestions and modifications.

A new, more limited, positive and constructive suggestion has been made. In 1946 the United States, through its occupation forces, destroyed the cyclotrons of Japan. This national error was acknowledged at

least partially through the influence of the federation. Perhaps it is now time to make good this act of depredation by assisting the Japanese to rebuild their nuclear physics laboratories. The desirability as well as the mechanism of such a program is yet to be decided.

For the coming year, the federation must define and carry out a dynamic program. This program must affirm and reaffirm our desire for international accord. In the absence of progress in this direction, the federation will continue to expend its efforts to strengthen the nation for peace or war.

LYLE B. BORST

Chairman,
FAS Executive Committee

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STUDENT DEFERRALS

Taking cognizance of protests from many quarters that deferment of higher ranking college students, as directed by the President involves undemocratic preferential treatment, council discussion stressed the importance to the nation of a steady supply of trained personnel. The council felt that some system of student deferment is essential, but agreed on the validity of the charge of discrimination against otherwise qualified young people who cannot afford to go to college. Accordingly, it adopted the following resolution as a statement of FAS policy to be appropriately publicized by the Executive Committee:

"Having considered the current controversy arising from the President's order to Selective Service Director Hershey governing the deferment of college students, the FAS Council has reached the following consensus:

"1. That in any program for student deferment, the broad national interest must be the determining factor. Neither special interest nor the charge of special privilege can be allowed to prevent the continuing training of a corps of specialized personnel in science and other areas so essential to the country's welfare.

"It must be clearly recognized that deferment of military service is for the purpose of additional training for later specialized tasks either in military or civilian capacity. Individuals so deferred, therefore, are not being granted special privilege but are rather selected for special responsibility.

"2. That any such program shall be designed to tap all available human resources by giving equal opportunity to every young person, on the basis of aptitude alone, to receive specialized training. To insure this, the standards for selection should be national in application and mandatory on local draft boards. To prevent exclusion of qualified young people who cannot themselves afford specialized training, a limited scholarship program should be initiated."

LOYALTY STANDARDS

The council recommended that FAS express disapproval of President Truman's executive order of April 28 redefining loyalty standards for federal employees and applicants for government jobs. Hitherto "reasonable grounds" for believing a person disloyal were required for denial of employment. The new order makes "reasonable doubt" of loyalty sufficient to bar an individual from federal civil service.

The text of the new regulation: "The standard for the refusal of employment or the removal from employment in an executive department or agency on grounds relating to loyalty shall be that on all evidence, there is reasonable doubt as to the loyalty of the person involved to the government of the United States."

In a brisk council discussion, delegates criticized the new policy on a number of grounds, chief among which were: (1) That the order sets an improper political test for public employment; (2) That loyalty is difficult either to define or to prove; (3) That the order, in effect, improperly extends the area of security and further confuses legitimate security risks with disloyalty; (4) That a negative decision on loyalty is, in effect, a defamation of character, and hence should not be reached without judicial procedure; and (5) That loyalty criteria fluctuate with the political temper of the times and their incautious application can result in intimidation of free thought. The council directed its chairman to summarize the discussion in a letter to the President, and in a press release.

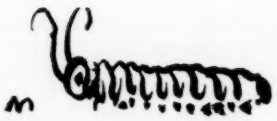
The President's order came as something of a surprise, despite the fact he had been urged to take such a step by two separate groups in the Executive Branch. The Loyalty Review Board (Chairman, former Sen. Hiram Bingham) made the first public suggestion. The President referred the matter to the Nimitz Commission on Internal Security and Individual Rights, which he had created to survey the whole controversial problem of federal employee loyalty. The suggestion was renewed on April 16 by Robert Ramspeck, recently appointed chairman of the Civil Service Commission, although it was opposed by CS Commissioner Frances Perkins. Truman had not been expected to take action until his own commission had made its recommendation. However, red tape halted the functioning of the Nimitz Commission almost before it started.[1] The group refused to work unless exempted from the "conflict of interests" statutes, which restrain federal employees (and hence the commission and its staff) from doing business with government agencies for two years after their withdrawal from service. The necessary exempting legislation passed the House, but has been rejected by the Senate Judiciary Committee whose chairman, Senator McCarran (and a prominent member, Senator Ferguson) has expressed open hostility to the Nimitz Commission.

CIVIL ATOMIC DEFENSE

The activity of several FAS chapters in local civil defense programs was reported to the council. Delegates generally were critical of the way civil defense is being handled (although unanimous on the need for civil defense in the present circumstances), and it was thought FAS groups could participate more fully at the local level. In addition, the preparation of a critical analysis of the civil defense problem was decided on, to be drafted by a group in the Mohawk chapter on the basis of official material and comments and reports of FAS members. The competence of the FAS in evaluating the power of atomic weapons, the resulting radiation hazards, the effectiveness of detection devices, etc., was considered sufficient justification for FAS to concern itself with the effectiveness of present CD programs. Comments and material may be sent c/o Dr. J. R. Stehn, 1421 Van Antwerp Road, Schenectady 10, New York.

[1] The Nimitz Commission resigned on May 12. See news item "Loyalty" on page 189 of this issue.

URANIUM RESOURCES



URANIUM resources and reserves continue to attract attention. In a recent informative article, Professor Paul F. Kerr[1] has reviewed the world situation in the light of recent developments. After a brief survey of the important uranium minerals, in particular pitchblende and carnotite, it is pointed out that certain guiding principles are emerging in the search for new uranium deposits. Thus, uranium tends to be associated with certain other minerals, principally cobalt, nickel, bismuth, and a few others, including small amounts of silver and gold. Further, many of the uranium deposits have been found in ancient Pre-Cambrian rocks, and it is believed "to be more than a coincidence that the chief uranium locations in the Belgian Congo, the Erz Mountains, Canada, eastern Colorado, and at several other places are all in Pre-Cambrian formations."

The uranium deposits which have been known for the longest time, are those in the Erz Mountains which form the boundary between the Russian zone of Germany and Czechoslovakia. The principal mineral here is pitchblende associated with silver, cobalt, nickel, and bismuth. The deposits occur in veins which were formed by precipitation from ascending solutions. Although considered of only minor importance before 1940, these deposits have been very intensively mined since then, and the total production from these deposits available to the USSR can only be surmised. In all likelihood it is substantial.

The largest and richest uranium deposits in the world occur at Shinkolobwe in the Belgian Congo, almost in the center of Africa. These deposits occur in a highly mineralized area noted for its production of copper, cobalt, tin, and diamonds. The deposits, although lying near the surface, lie in ancient Pre-Cambrian rock. It appears that here also the uranium came from deep in the earth dissolved in hot solutions from which uranium then deposited.

The uranium deposits of Canada occur in a somewhat similar rock formation. Here the ancient rock is exposed by erosion. The original Eldorado deposit was discovered at Great Bear Lake in 1930, and was intensively worked during the war. Since the end of the war, the great Canadian shield has been extensively prospected and uranium has been found in a zone which extends from Great Bear Lake southward through Great Slave Lake and Lake Athabaska and finally eastward along the northern shore of Lake Superior. The deposit near Lake Athabaska is about to begin producing, and it is estimated that this deposit will yield an amount of uranium comparable to that from the Eldorado site.

The third major source of uranium in the world today is the carnotite deposits of the Colorado Plateau in the United States. The deposits here are of sedimentary origin and occur in old sandstones formed in what seems once to have been a shallow fresh-water sea. Deposits of carnotite underlie great portions of Colorado, Utah, Arizona, and New Mexico. In addition to the carnotite deposits, pitchblende in significant amounts has been found in Utah, Idaho, western Montana, and northern Michigan. Whether these will become important remains to be seen.

These, then, constitute the known uranium deposits. Isolated occurences are widely disseminated all over the world, and new prospecting methods will serve to locate these. In addition, there are known to exist low concentrations of uranium in the gold ore of the Rand in South Africa, in the phosphate rock of Florida, Idaho, and western Wyoming, and in the black shale of Tennessee. Although the uranium content is very low in these substances, nevertheless in the aggregate they constitute an enormous potential reserve.

Professor Kerr speculates about the uranium resources available to the USSR. Little information has appeared in print since 1944. Before then, the principal Russian deposits were considered to lie in the black shales and slates in Asiatic Russia between Lake Balkash and the Afghanistan border. These deposits are of very low grade, comparable perhaps to the Tennessee shales of this country. Press accounts indicate that some three thousand geologists are exploring for uranium in the USSR, that hundreds of thousands of Russian workers are engaged in mining and hunting uranium, with digging and prospecting going on in 230 locations in Eastern Germany alone. Professor Kerr concludes that "the present uranium production available to the USSR is seriously large."

As mentioned above, the chief domestic source of uranium is the Colorado Plateau. These deposits are discussed in some detail in two recent speeches.[2] The Colorado Plateau has been the scene of considerable activity. Of principal interest is the fact that the geologic areas favorable for uranium occurrence have been greatly extended. Today, the entire Colorado Plateau consisting of some 130,000 square miles of Colorado, Utah, Arizona, and New Mexico is considered to be a favorable area. The principal production has been and is being presently obtained from the Salt Wash sandstone member of the Morrison formation. The bulk of the ores mined contain about 1.5 per cent vanadium and 0.2 to 0.4 per cent uranium. The area of known mineralization has been extended southward into New Mexico and Arizona, and westward into Utah, with an outstanding discovery being made in the Lukachukai Mountains in the Navajo Indian Reservation of northwest Arizona.

Another group of formations, the Moenkopi-Shinarump-Chinle, of southern Utah and Arizona, are becoming of increasing importance. These formations contain the so-called copper-uranium ores. New uranium deposits are continually being found, but development has been retarded by the difficult nature of the terrain. It is interesting to note that outcroppings showing as little as 0.04 per cent U_3O_8 must be regarded as potential ore producers, since it is believed that unoxidized portions of such mineral bodies may contain ore averaging several tenths of a per cent U_3O_8.

Short of a rich strike along the lines of the Belgian Congo, it would appear that the Colorado Plateau will be our principal source of uranium for some time to come.

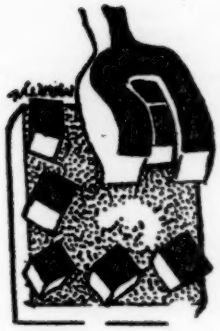
—J. J. KATZ

[1] Paul F. Kerr, "The Earth's Uranium," *Scientific American*, May 1951.

[2] P. L. Merritt and D. L. Everhart, delivered before the American Association of Petroleum Geologists, St. Louis, Missouri, April 26, 1951.

THE ROLE OF ATOMIC ENERGY IN THE WORLD ECONOMY

GORDON DEAN



The following article is based on two recent speeches by the chairman of the United States Atomic Energy Commission. In the first, dealing with the relation of atomic energy to economics, he assesses our supply of raw materials. In the second, concerning the relation of atomic energy to law, he outlines the areas of the atomic energy program which should lead—but have not yet led—to significant new developments in the field of law.

IN VIEWING our own atomic energy program with respect to world economy one clear fact emerges: as of today the role of atomic energy in this nation's economy is more negative than positive. That is to say, our atomic energy program is taking more out of the wealth and resources of our country than it is putting in.

There is nothing that illustrates this point more vividly than the fact that the Atomic Energy Commission has recently entered into a contract with a new company called "Electric Energy, Inc." whereby the company will supply approximately one-half of the power needs of the commission's new uranium separation plant to be built near Paducah, Kentucky. To do this the firm will have to build a new steam plant to generate power in Illinois—near Joppa, in the south of the state. When the day comes that a company called "Atomic Energy, Inc." is formed to provide power for the electrical systems of this country we will be in a much better position to discuss intelligently the positive impact of atomic energy upon our economy. The fact remains that while the world ultimately looks to the atom to produce power the atomic energy program is today the largest single *consumer* of power. This is not a pleasant fact but it is a fact.

We have, then, two phases of atomic energy development. One—the phase we are in now—where atomic energy development is largely (and I think necessarily) *controlled*, and its impact is largely negative; and two—the phase we shall inevitably reach at some point in the future—where atomic energy will be unfettered and its impact will be largely positive. This will be the phase in which atomic energy will add to the wealth of the world. There are a great many variables in any determination of just when this day will come, and some of them are variables over which we in the Atomic Energy Commission have little control. Not the least among these variables are the plans and actions of the men who direct the destiny of the Communist world.

Our two sets of objectives—those having to do with defense and those having to do with peacetime economy—are not unrelated. Most of what we accomplish in the one area is of definite value to the other. We are, therefore, along with our weapons work, and partly because of it, advancing toward the day when the technical feasibility of utilizing atomic energy for industrial and other purposes will be demonstrated. We have every hope and every reason to believe that such a day will arrive.

Before we look more closely at the role atomic energy may play in our future economy, let us examine the impact that it is having on our economy today—this negative impact. For how we handle the problems that confront us today will undoubtedly have a very important if not decisive bearing on the future.

To examine the negative impact of atomic energy development on our economy today is to raise some questions:

Is this impact too great? Are the returns we are receiving in the area of national security and the returns we hope to receive in the future in peaceful benefits worth the sacrifices we are making? These are particularly pertinent questions at this time when we are engaged in a tremendous expansion program.

Or, on the other hand, are our efforts perhaps not great enough? Could we safely be doing more? Could our economy, burdened as it is with our great defense mobilization program, stand a greater strain and would the results we would achieve be worth it? In answering, remember that in the fiscal year 1951 Congress has appropriated about $2 billion for the Atomic Energy Commission and that the appropriations for the Military Establishment have been to date about $42 billion, and requests for more are to come.

Whether we can stand greater strains is still a hard question to answer.

THE STRUCTURE OF THE ATOMIC ENERGY PROGRAM

To understand the setting in which it must be considered, it is helpful to understand the general nature of the atomic energy program and the factors which determine its magnitude. To do this let us visualize a schematic presentation in the form of a pyramid. The base of this pyramid is composed of raw uranium ore. Upward at succeeding levels are the great feed materials processing plants, uranium separation plants, plutonium-producing reactors,

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Speeches given at Northwestern University Centennial Conference on Science, Technology, and World Resources on February 28, and at University of Pittsburgh Law School on February 15.

research and development laboratories, weapons facilities, and testing areas—and throughout there is a vast accumulation of intricate and expensive equipment and highly trained people. At the peak are the end products—atomic weapons, isotopes for use in industry, agriculture, research, and medicine, and a considerable amount of technological information of infinite value to tomorrow's economy.

As this pyramid is increased in size—something we are doing at a growing rate at the moment—points of resistance are met at a number of different places. There may, for example, be a shortage of reactor technicians at one point, thus limiting the over-all size of the structure, or there may be a critically short material at another. Or perhaps there are too few skilled construction workers here, or two small a capacity to supply vital equipment there. At each point where resistance is encountered it can be overcome, but sometimes at a very high price. For example, we may be able to obtain an adequate supply of some critical material only to find that we are taking it away from general industry, or more important, perhaps from some other vital part of the national defense effort.

Parenthetically I should like to give you some idea of the magnitude of our expansion effort. To date, the Congress has appropriated more than six billion dollars for atomic energy in this country. Two of these six billions were appropriated during the current year—a sum comparable to the entire amount expended by the Manhattan Engineering District on atomic energy during World War II. In the personnel field alone it has been estimated that 5 per cent of the total scientific and engineering population of the country is engaged in atomic energy work. I have referred to some of the limiting factors which determine the size of our program. *But the ultimate size is determined by ore.* In other words, while our program might be made big enough—at a sacrifice—to handle almost any supply of uranium ore, the program is a pyramid and ore is the base. Uranium then is crucial.

THE AVAILABILITY OF URANIUM

When one considers the future of atomic energy development it is encouraging to reflect that one part in each 250,000 parts of the earth's crust is uranium. On this line of reasoning it can be pointed out that uranium is one thousand times as plentiful as gold, one hundred times as plentiful as silver and almost as plentiful as lead or zinc.

One might ask, "If this is true, why don't we go all out to get this uranium out of the ground and into the form of bombs? Why are our activities limited to the relatively rich deposits?"

We could do this if we were willing to pay the cost. We could, for example, and I choose this example fully aware that it is extreme, extract uranium from sea water. It is well known, for example, that magnesium is extracted economically from sea water. It is also known that in sea water there is uranium which has been calculated to occur at a ratio of about five tons per cubic mile. We could get this uranium. But let us consider, for a moment, what this would cost.

In the first place, magnesium is much more prevalent in sea water than is uranium. It has been estimated that if we were to build a plant the size of a normal economical magnesium sea water processing plant we would get on the order of only 50 to 70 pounds of uranium from it per year. Two scientists, several years ago, calculated that to obtain uranium from sea water at a rate of 100 tons a year—enough to make it an interesting source—we would need a plant capable of processing 12 million tons of sea water per hour, and the cost of such a plant was estimated at in the neighborhood of 150 *billion* dollars.

This, I believe anyone will agree, would be an uneconomic way of obtaining uranium. We could do it, but what would we have done to our economy in the process? What would we have done to the rest of our defense effort?

The fact is that, although uranium composes one part in each 250,000 parts of the earth's crust, significant concentrations occur very sparingly.

We now mine some deposits containing but one part of uranium oxide to each 1,000 parts of ore. Like other minerals, those deposits which can be mined most economically, whether because of grade, accessibility or the presence of other valuable materials in the ore, are mined first. Today the great bulk of our supply of ore comes from those deposits—the Congo, Canada, and Colorado.

But where do we go from here?

First, we have a program under way to stimulate exploration. We want to find other deposits—preferably high-grade.

Second, we are turning increasingly to lower grade deposits. The most obvious of these are deposits where uranium can be had as a by-product of the production of some other valuable mineral. For example, we recently announced that the United States and the United Kingdom had entered into an agreement with the Union of South Africa whereby we will obtain uranium produced as a by-product of gold production. Pilot plants for the extraction of uranium are already in operation at some of the South African gold mines.

Third, we are vigorously pursuing a research program that we hope will produce economic methods for extracting uranium from such other very low-grade deposits as the phosphates.

And fourth, we have just today increased the prices we pay for uranium in *this* country and the bonus we will pay for production from new mines. This is an important step. It will make production from lower grade deposits more profitable to the miner; it will stimulate development of known deposits whose extent is now still largely undetermined, and it will stimulate our exploration program.

Dr. Vannevar Bush in his stimulating book, *Modern Arms and Free Men*, said: "To build a large stock of atomic bombs is an undertaking that will strain the resources of any highly industrialized nation. The strain will be greater if very dilute sources of raw materials have to be utilized, as seems probable."

By such actions as we have taken today we are gaining access to more dilute sources of these raw materials. But we are doing it at a price—to the taxpayer and to our economy. At this point I'm convinced the price is not too great.

ITS IMPACT ON THE LAW

With very few exceptions, if a lawyer is interested in atomic energy today, he is interested not as a lawyer, but only to the same extent that every other citizen is interested—wondering what it all means for him as a father and a citizen. The enactment of the Federal Communications Act was followed by the formation of a communications bar. We have patent bars, admiralty bars, and so forth. Perhaps my point is best made when I say that we have no atomic energy bar. In fact, so far as I know, there is only one bar association in the country which has, in a moment of "what can we lose by it," set up a committee which is to look into atomic energy matters. And there have been fewer articles published in the law journals of the country dealing with atomic energy than ar-

ticles dealing with such subjects as the legal aspects of artificial rain-making.

Our program is loaded with poisons and hazards that would ordinarily make the negligence lawyer lick his chops. Permit me to indicate some of the points in our processing chain where these occur.

We confront these hazards in all the stages of preparing the feed materials for introduction into our plants at Oak Ridge and Hanford; for example, in the drying and the crushing and the packaging of these feed materials, radioactive dusts and washings will occur. In all of the stages from black oxide to orange to brown oxide, to green salt and uranium hexafloride we face the problem. We face it even when we bring uranium to the metal stage, in the rolling, extruding, and machining of the metal.

We must face up to it in serious fashion when we come to the handling of the radioactive wastes from our production reactors, for while we sometimes refer to the waste materials from these reactors as "ashes of our nuclear furnaces," the grim fact is that they may not be treated as ashes since they contain highly dangerous fission products.

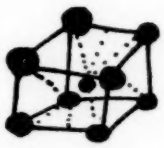
Certain precautions must be taken in the case of water-cooled reactors to guarantee that long-lived radioactivity will not be carried back to streams. Other problems are presented in the air-cooled reactors such as the Brookhaven reactor where the cooling air is cleansed and freed of particles which upon exposure to the neutrons in a reactor would become radioactive.

In the research laboratories various contaminants are found in the discharge from the ventilation hoods; in addition, a wide variety of wastes may result depending upon the nature of the work. Monitoring instruments are used extensively. And the vessels which are used must either be decontaminated or destroyed. Even in the laundering of special clothing worn in the laboratories, a considerable amount of waste results which is difficult to treat. Combustible wastes are not disposed of by burning, since to burn them would not get rid of the gases unless provision were made to decontaminate the gases of combustion.

There are then potential hazards throughout the program. But with all of it the remarkable thing is that the AEC and its contractors have been able to maintain such an outstanding safety record. Here, I think, lies the answer to why the hazards of the program have not led to litigation. Although tens of thousands of persons have worked in production and weapon plants and research laboratories during the last six years, very few have suffered injuries. In May 1946, nine persons were exposed in an accident during an experiment in bomb physics. One died and two others suffered injuries. The remaining six have apparently escaped unhurt. Several months earlier a similar accident had killed one man. Since May 1946 only five persons have suffered injuries—all of them local. Four of these occurred during the Eniwetok bomb test in May 1948.

An advisory board on safety and industrial health, a group of twelve distinguished authorities appointed by the commission to survey practices in this field, reported in 1948:

"History affords no parallel to the thorough study of and protection against radiation hazards to workers from the inception of the project to the present."



This then accounts, largely, for the fact that while the commission has carried this heavy responsibility for the control of radiation hazards it has discharged it in such a way as to provide few opportunities for the tort lawyer. In fact, in our over-all operations, some of which present no distinctive hazards, the 1949 accident rate for all our employees and those of our contractors was 4.94 injuries per million man-hours compared to 11.49 injuries in American industry.

The hazards of radiation are not reflected in case law or the statutes of the country.

ATOMIC ENERGY LEGISLATION

Aside from the Atomic Energy Act of 1946, there seems to be no atomic energy legislation except for slight changes in the workmen's compensation laws of a few states. For example, the Tennessee and New Mexico statutes were recently amended so that compensation could be paid for radiation injuries; and in New York, the time limit for filing claims was increased to take care of delayed illnesses such as radiation sickness and beryllium poisoning.

The Interstate Commerce Commission, in November of 1947, published a regulation regarding the interstate shipment of radioactive materials, and the Division of Industrial Safety of the State of California has issued an order to set up minimum standards for protection of employees exposed to ionizing radiation. The field however is so new that it has been difficult to frame legislation which would in any way be realistic. The National Bureau of Standards has the Committee on Radiation Protection whose function it is to set up radiation standards and to determine permissible limits and tolerances. While it has no authority to enforce observance of these standards, doubtless the standards adopted from time to time would have status in any litigation involving radiation injury, and would be considered by those drafting laws or regulations.

Admittedly we have played safe in so far as radiation hazards are concerned. Our knowledge was insufficient—our experience limited. Tolerance levels were therefore set low. Elaborate and costly precautions were and are now being taken. However, as industry participates more widely, and particularly when it ventures its own risk capital, we may expect that these elaborate devices will be re-evaluated and that we will come to accept the hazards of the industry as we would those of any other where good safety procedures are followed.

PERSONNEL CLEARANCE

I should like to turn briefly to another field where one might have thought that the impact of the atom on the law would have been substantial. I refer to our system of personnel clearance. Under the Atomic Energy Act every employee of the Atomic Energy Commission must be investigated as to character, loyalty, and associations. Every employee of a contractor of the commission who is to have access to "restricted data," within the meaning of the act, must be similarly cleared. Whenever the layman thinks of the atom, he thinks of secrecy and in thinking of secrets he thinks of the people who under the act are to be entrusted with them.

Without regard to the thousands of people in the Military Establishment who have access to classified information as a result of military clearances, and without regard to the score of thousands of persons who had access to classified information under the Manhattan Engineering District dur-

ing the last war, there have been more than 200,000 persons who have been considered for clearance since the enactment of the McMahon Act.

What effect has this had on law, procedures, and lawyers? I submit very little. In the first place, less than 1.5 per cent of the investigations have revealed any apparently derogatory information significant enough to raise a question about clearance of the individuals concerned. Nearly all such cases are disposed of without the necessity of formal hearings. In fact, since the commission established local review boards in the spring of 1948 only 105 cases have gone to formal hearing. This is a field in which lawyers, because of their background, have a natural interest. The clearance of people for access to restricted information smacks slightly of the investigations and determinations which accompany criminal cases. From the standpoint of the country this is a very important phase of the commission's responsibility. And it is a responsibility which is twofold—there is first the responsibility to see that enemies of our country do not get into this program. There is also the responsibility to see that people who wish to enter our program, or who are already in our program, are treated fairly and decently. There is combined in the commission much of the same responsibility as that which is imposed upon a judge.

As you know the remedies available, other than the right to a hearing when derogatory information is uncovered, are limited, and somewhat the same rules apply as under the President's loyalty program initiated in the fall of 1947. While the legal problems are rather limited, I think it worth while at this point to explore with you the reasons for such checks upon our people. Aside from the persons who may be untrustworthy because they are emotionally unstable—excessive drinkers, congenital gossips, etc.—there are roughly five categories of persons who are potential trouble-makers in a sensitive program such as the atomic energy program, and when I sketch these categories, remember that I have no doubt but that the primary espionage target from the standpoint of a potential enemy is the Atomic Energy Commission's program.

First, there is the category which would include the mentally deranged, the fanatic, the assassin. These can either be detected by a clever diagnostician or, if not detected, the only recourse is in the form of steel fences and guards who will frustrate their unreasoning plots. We might label these "the blunt fanatics."

There is a *second* category, which includes the ideological types who for one reason or another are detractors of our democratic institutions, but who unlike the fanatic simply want an outlet, an opportunity to speak and most of all an audience. For these people the Hyde Park treatment and the soapbox audiences usually suffice. Many of the professional joiners will be found in this category. It is in this category that we find many of the "association" cases, the joiners of "front" organizations and the question is always: "Is he just a simple joiner?" or a well-motivated "do-gooder?" or is he on the other hand something more dangerous?

This brings me to a *third* category that we will always have with us and certainly trouble-makers in this group are the most difficult ones to detect. These are drawn by an ideology to find that spot from which they can most effectively commit a traitorous act. They are smart and blessed with education. They are controlled people. No party cards for them; no foolish acts; no rules and regulations other than the rules and regulations and loyalties of their own creed. These are the people, of course, who can do us the most harm. These are the people whom we are least likely to detect. Being smart and composed and plausible, they will quietly seek their places in the program and bide their time. We might call them "the traitors."

There is a *fourth* category—the paid spy. No ideology motivates him. He is a traitor for pay.

And there is certainly a *fifth* category which would include the dupes and stooges. They are the people who are used. They are the victims of the people in categories three and four. They will be recruited from the ranks of the minorities—racial, religious, and economic minorities. We might call them "the sheep."

I have, of course, greatly oversimplified the situation when I carve out five such types, but I think it is helpful to do it nevertheless. One thing that marks the persons in all five categories is the lack of a sense of humor. I have frequently thought in facetious moods, that since this stands out so markedly in the case histories of those who are unacceptable, that if we're really to play on the safe side, we might well eliminate from our program all those who did not have a good sense of humor. None of our last crop of dictators was blessed with one and none of our current crop of commies, and, with one possible exception, none of the communist leaders is so blessed.

I have strayed somewhat from the impact of the atom on the law. Permit me to conclude this digression by saying that if we were required in our program to apply the criminal law test of virtual certainty of guilt, our program might soon be effectively sabotaged.

I say this at the same time subscribing fully to Professor Schlesinger's warning:

"There are spies and there are victims of gross injustice; the problem is to preserve an atmosphere in which effective judicial determinations as to which is which can be made. . . . There is no easy answer to this conflict of principles between civil liberty and national security in the field of government employment. The practical results then must depend (too much for comfort) upon the restraint and wisdom of individuals. If we cannot handle this conflict of principle soberly and responsibly, if we cannot rise to the world crisis, then we lack the qualities of greatness as a nation and we can expect to pay the price of hysteria or of paralysis. Civil liberties do not deny society its right of self-protection. They only make sure that this right is used, not to punish dissenters or to flail at nightmares, but to ward off real dangers to the commonwealth."

NEWS AND NOTES

Prepared by PETER AXEL

LOYALTY

A Presidential directive, two Supreme Court decisions, and the resignation of the Nimitz Commission contributed in a contradictory manner to the federal loyalty program. President Truman's executive order of April 28 made it easier for loyalty review boards to discharge or deny employment to any individual by changing loyalty criteria. Whereas in the past it was necessary to have "reasonable grounds" for believing a person disloyal, in the future "reasonable doubt as to the loyalty" of a jobholder or applicant will disqualify him.[1] The stringency of the loyalty program was also increased by one of the Supreme Court decisions which affirmed the administration's right to dismiss a civil service employee on the basis of current loyalty test regulations, which provide no rights of confrontation or cross-examination.

On the other hand, in a decision announced on April 30, the Supreme Court cast doubt on the validity of the Attorney General's list of two hundred allegedly subversive organizations. The Court ruled that "some kind of hearing" had to be granted to three organizations which had challenged their listing. While this ruling does not prevent the continued use of the Attorney General's list as a guide to "loyalty," the Supreme Court, in effect, criticized the arbitrary manner in which the list was compiled. Thus, the complexity of the problem of deciding whether a person is "loyal" was again emphasized.

The Nimitz Commission, which was to have studied this problem, resigned on May 12. The President had appointed the commission to investigate and "report on the effectiveness and the fairness of the government's loyalty and security programs." The group had never been able to function because Congress proved unwilling to exempt its members from the rule requiring federal employees to give up the right to transact business with the federal government for two years after the termination of their work for the government.[1]

[1] See discussion in excerpts from *FAS Newsletter* on pages 182-83 of this issue.

BOMB TESTS

The "major purpose" of the test program completed in Eniwetok between May 1 and May 11 is classified information, but it was announced that the tests "included experiments contributing to the thermonuclear weapons research." In their joint news release of May 25, the Defense Department and the Atomic Energy Commission also stated that "information on several projects in fields of biology, medicine, and radiobiology, will be declassified and provided to appropriate agencies of the government when the results have been analyzed and evaluated." The tests also included a study of the "measurement of blast and thermal effects on structures, aircraft, and various other items."

Although this official announcement was very brief it was the only authentic information on the bomb tests. The reference to the thermonuclear weapons was generally interpreted as meaning that the possibility of triggering a hydrogen bomb by a fission bomb has been tested. This may have involved merely measurements of the temperature generated by fission bombs; but more probably it meant actual tests of explosion of small quantities of thermonuclear materials (deuterium and tritium) enclosed in an atomic bomb.

INDUSTRIAL REACTOR STUDIES

The Atomic Energy Commission reported the first positive step in its program to encourage private enterprise to join in the development of nuclear reactors for industrial and power applications. On May 16, the AEC announced the completion of negotiations with three groups of industrial concerns for special studies in the feasibility of private participation in the atomic energy program. These groups which have accepted the agreements are:

1. The Detroit Edison Company of Detroit and the Dow Chemical Company of Midland, Michigan.
2. The Commonwealth Edison Company and the Public Service Company of Northern Illinois, of Chicago, and
3. The Pacific Gas and Electric Company and the Bechtel Corporation of San Francisco. In addition, the Monsanto Chemical Company and its associate, the Union Electric Company of Missouri, of St. Louis, are expected to reach an agreement with the AEC in the near future. The AEC further announced that these four studies are the maximum number which can be undertaken simultaneously. Each study group will consist of a maximum of fifteen cleared company personnel who will have access to reactor installations. The maximum time limit on the current studies is one year.

AEC PERSONNEL

Dr. K. S. Pitzer is resigning as Director of Research for the AEC and will become Dean of the College of Chemistry at the University of California. Dr. Pitzer's resignation, effective June 18, will conclude two and a half years of service as director of commission-supported research in the national laboratories and at various universities. Dr. Pitzer's successor had not yet been selected when his resignation was announced on May 8.

Dr. Henry DeWolf Smyth, on leave from the Physics Department, Princeton University, was nominated by President Truman on May 21 for a new five-year term as a member of the Atomic Energy Commission.

SCIENTIFIC ADVISORS TO ODM

President Truman appointed eleven scientists to an advisory committee which will be part of Charles E. Wilson's Office of Defense Mobilization. The group, which will advise on all scientific activities related to defense

mobilization, will be under the direction of Dr. Oliver E. Buckley, President of Bell Telephone Laboratories. The other ten members of the committee are: Dr. Detlev W. Bronk, Dr. William Webster, Dr. Alan Waterman, Dr. Hugh Dryden, Dr. Lee DuBridge, Dr. James B. Conant, Dr. James R. Killian, Dr. Robert F. Loeb, Dr. J. Robert Oppenheimer, and Dr. Charles A. Thomas. The science committee, which will have only advisory responsibilities, is the sixth division to be created in the ODM. The other divisions are manpower, transportation and storage, production, economic stabilization, and housing.

USE OF ZIRCONIUM

On March 6 the AEC announced plans to encourage industrial participation in the manufacture of high purity zirconium, a little-used element of potential importance for the nuclear reactor development.

At present, zirconium meeting the required rigid specification is produced mainly in AEC's own facilities. Information pertaining to the processes which have been developed will be made available to private firms willing to undertake the production.

Zirconium absorbs relatively few neutrons and some of its compounds can withstand very high temperatures; one crystalline modification of zirconium oxide was recently stated to be usable even at 4500 degrees Fahrenheit. (In the January 15 issue of the *Wall Street Journal*, it was reported that this modification was prepared by the Norton Co. of Worcester, Massachusetts.)

ATOMIC ENERGY IN ARGENTINA

The *Bulletin* has received a 10,000-word interview that Mr. Ronald Richter had with the press on March 26 concerning the Argentine atomic energy project. A careful perusal of this statement fails to reveal anything indicative of the kind of experiments which Mr. Richter has allegedly been performing. He claims having made three "basic discoveries" which have permitted him to obtain the high temperature necessary for the initiation of thermonuclear reactions without the help of fission, and without high-voltage accelerators. What this temperature is, what was the size of the "reaction zone" in which it was obtained, and by what means it was produced he doesn't say. He mentions, however, that the temperature was measured by observing the Doppler displacement of ultraviolet spectral lines emitted by the reaction zone, and that molecular velocities of 3,200 kilometers per second were registered.

Since then, a Brazilian newspaper has reported that Dr. Richter has been arrested by Peron for misleading him. This rumor might have something to do with the official announcement by the Argentine government late in May that President Peron personally has taken over the leadership of the atomic energy project.

MISINFORMATION DEPARTMENT

John J. O'Neill on May 20, reported in the usually sober *New York Herald Tribune* that "there is enough uranium in the United States, refined and ready for use in the chain reaction state to produce at least 70,400 atomic bombs." Mr. O'Neill continued "this is a low minimum estimate. A more correct minimum estimate would be 281,600 bombs." The remainder of the article rivaled scientific fiction as it produced technical terms and numbers to justify the fantastic estimate. The misconception most responsible for it was that purified ordinary uranium (U-238), now invested in nuclear reactors, could be used "for quick transformation into atomic bombs."

★ ★ ★

United Press on May 12 quoted Representative Henry M. Jackson, Democrat of Washington, as saying, "We learned [at Eniwetok] that troops can follow up immediately over an area destroyed by an atomic blast with no fear of lingering radiation." This had been known theoretically before the first bomb was exploded, confirmed by the Alamogordo test explosion, and all subsequent aerial tests, and was publicized by the civil defense program which calls for rescue workers to rush into a bombed area as soon as possible after an air blast.

FOREIGN ATOMIC ENERGY DEVELOPMENTS

Recent atomic energy advances abroad were summarized by Gordon Dean, chairman of the AEC, in a speech in Dallas, Texas, on April 20 as follows:

Britain is building a plant for the production of plutonium (at Sellafield) in addition to its two atomic research piles at Harwell. One of the Harwell piles produces radioisotopes which are available to other nations for research and development. The British are also engaged in the development of atomic weapons.

Canada's atomic activities are concentrated at Chalk River, where more than a thousand people are employed. They have two research reactors and a third, capable of producing plutonium, is under construction. NRX heavy water pile at Chalk River is famous for producing a higher density of neutrons than any research reactor in operation in the United States.

France began her atomic experiments at Fort Chatillon near Paris. This laboratory now employs 1,600 people and has a low-power research reactor in operation. A new atomic center at Saclay has recently been opened; a larger reactor is being built. A third reactor, large enough to produce plutonium in significant amounts, is also planned for Saclay. *Norway* and the *Netherlands* are jointly building a heavy water reactor near Oslo in Norway, and *Sweden* is building a nuclear reactor for industrial power research.

In addition to the developments cited by Mr. Dean, *India* is planning a small atomic pile for experimental purposes, according to a statement made in the Indian Parliament and reported by AP on March 24.

The National Assembly of France has voted by 371 to 211 votes on a cut of $2,800 in the government's atomic energy budget. The full $2,000,000 appropriation will be restored when the government declares that the project has been freed from Communists or communist sympathizers. The delay in the official appointment of Professor Francis Perrin as successor to Professor Frédéric Joliot as head of the French atomic energy project was attributed by newspapers to this "purge." This appointment was finally announced on April 22.

QUOTES

Stewart Alsop (*New York Herald Tribune,* May 16, 1951):

". . . An entirely new and extremely significant tactical use for the atomic bomb is now envisaged.[2] The fact[3] that there are plans for exploding an atomic bomb underground has already been published elsewhere. There are reasons for believing that one underground test has already taken place in the Aleutians. If not, such a test will soon take place, and will be followed by other tests of bombs of different degrees of power exploded at varying depths.

"The real meaning of this is simple. Theoretically, at least, it would be immensely difficult and perhaps impossible for an advancing army to clear a safe path through the vast weight of contaminated radioactive soil thrown up by an underground atomic explosion. It is true that this soil would remain lethally contaminated only for a few days or weeks, and true also that the area affected would not be unlimited. Yet it is obvious that, if the tests are successful, this new technique for denying vital ground to an advancing enemy could also have a profound effect on the course of any future war."

D. Lilienthal (*Collier's,* March 10):

". . . Leaving aside moral and political considerations, the first military consideration in the use of the atomic bomb, is . . . the existence of appropriate targets, militarily worth the expenditure of atomic weapons. Such targets might include great masses of men and equipment such as might be assembled in an invasion force. But against smaller targets, single industrial plants, an airfield, troops deployed in the field, a file of tanks, the use of atomic bombs would be militarily extravagant and unprofitable. . . . The bigger an explosion, the more costly the weapon, both in hard-to-come-by materials and in dollars; and the fewer the appropriate targets. . . .

". . . Much of the support for attempting the H-bomb rests upon a blind acceptance of the belief that the force of explosion is equivalent to military value; and on a dangerous confusion of a means of creating terror with methods of carrying on military operations. . . . The limitations on the usefulness imposed by the explosive size of the A-bomb are even more apparent in the case of the H-bomb. Here they are sufficiently severe to raise serious questions as to its potential military value, and, therefore, the value of attempting to achieve it. For while the theoretical possibility has long been known, it is not generally realized that the effort to translate that possibility into reality will tie up a goodly portion of the top scientific and technical talent of the country as well as cut substantially into the supply of scarce materials and facilities needed throughout the defense program. . . . Production of fissionable material that could be made into A-bombs will have to be diverted for the production of the hydrogen-bomb material."

[2] See *Bulletin of the Atomic Scientists,* May 1951, p. 154.

[3] No official announcement of such a pending test has yet been issued.

Glennan: New Horizons in Isotopes Field

(*Continued from page 176*)

their place in the main stream of the U.S. and world economy, far greater numbers of skilled isotope technicians are required. Ideally, what we should have here is a sort of chain reaction, with the people trained by government in turn being utilized to train others, and so on. Much of the responsibility for progress in this field rests, of course, with the colleges and universities, but it also rests with industry, which, with in-service training programs, scholarships, and the like, could add substantially to our supply of skilled isotope technicians.

2. A considered awareness by industry of the health and safety factors involved in the large-scale use of radioactive materials. As of today the hazards associated with the use of radioisotopes are controlled by the commission largely by the simple method of not selling isotopes except to people who know how to use and dispose of them safely. This is an effective means of controlling any hazards to the public health and safety so long as the government is virtually the sole producer of isotopes and isotopes are used on a relatively small scale. Ultimately, it seems to me, if isotopes are to find their rightful place in the economy, they will have to be handled in much the same way as other toxic and hazardous materials, that is, by state and local public health officials working closely with an industry that respects the dangers involved and has developed a sense of responsibility about the health and welfare of the general public.

3. Careful consideration and advanced planning by industry in regard to the economic factors involved. As I said earlier, some substantial part of the growth of the United States isotope program to date is due to what amounts to a considerable governmental subsidy of isotope production and distribution. This raises some questions for the future. For example: Can private industry, which presumably must amortize the cost of its basic equipment, produce isotopes at sufficiently low cost? What new production techniques might make production economic? How big is the ultimate market for isotopes? How will the price affect this market? I don't propose to attempt to answer these questions now and I don't even know whether there are any good answers today, but I do think they are questions that must be given careful consideration before we can expect the isotope business to become a private one.

4. An intensive study by industry of all of the possible uses for isotopes, in process control, production, testing, and research. It is my personal belief that the maximum potentialities of isotopes have not yet even begun to be realized, and considerable research must be accomplished before we can make any safe predictions. As I am sure you will be told by other speakers at this conference tomorrow, the commission is now sponsoring a research study by the Stanford Research Corporation into the possible uses by industry of fission products. This is a step in the right direction, but it will take many such steps, with industry not merely cooperating but actually taking the leadership, before the maximum possibilities of isotopes are known.

CIVIL DEFENSE NEWS

Prepared by ARTHUR H. JAFFEY

PHILADELPHIA TEST EXERCISE

A fourth large-scale "test" of a major city's civil defense plans was recently carried out in Philadelphia, involving the use of a hypothetical attack problem to test the previously formulated defense plans. The three-day "critique" which followed was attended by 1,200 civil defense and government leaders. The attack problem involved the explosion of two atomic bombs, more powerful than those used in Japan, over heavily populated areas of the city, with resulting tremendous theoretical damage and loss of life. The problem included detail as to the number and type of casualties and damage occurring in various parts of the city and surrounding communities, and the various divisions of the defense organization were limited to the use of facilities and procedures outlined in the plans frozen prior to the setting of the problem.

Although many important conclusions were drawn from this exercise, the most significant one was that "no city and no metropolitan area of the United States, no matter how professional its civil defense plans nor how rich its resources, could meet a major enemy attack alone and unaided." The necessary aid must come from neighboring communities at the time of attack and from state and federal government in the form of funds, equipment, and guidance prior to attack.

NATIONAL CIVIL DEFENSE CONFERENCE

In an attempt to arouse public interest in immediate civil defense preparation, Administrator Millard Caldwell of the Federal Civil Defense Administration called a conference on May 7 for about 1,000 leaders of 300 national organizations. Its purpose was to educate civil leaders to "spearhead a program of education." Among the speakers were President Truman, Assistant Secretary of Defense Edwards, and Governor Warren of California.

President Truman pointed out that, according to our air force, it was impossible to prevent the bombing of this country, in the event of war, and that such bombing would undoubtedly be atomic in nature. He urged the intensive organization of civil defense programs to minimize the casualties arising from such bombing.

Secretary Edwards declared that the ability of cities to recover from attack and the ability of the people to keep on fighting would help considerably in deterring other nations from starting a war with the United States. In addition, should war come, a thoroughly organized civil defense, he said, could cut the casualty rate in half.

Following these keynote speeches, the conferees were introduced to many of the more technical problems, such as those of finance and organization details. Raymond Spencer, of the FCDA, pointed out that present thinking on shelters indicated that basements were not good shelters, unless extensively modified to protect them from rubble, flying glass, and the danger of people being trapped in debris.

The country's civil defense program has been widely criticized as inadequate and slow in being organized. While Philadelphia's plan is one of the best in the nation, it is still on paper, and a long way from being expressed in action, in the form of a going organization. Most of the rest of the nation is behind Philadelphia in the development of its organization and planning. This slow growth has been blamed upon public apathy, resulting from ignorance either of the potentialities of atomic warfare or of the possibilities of greatly reducing casualties by appropriate civil defense measures.

PROPOSED PUBLIC ATOM TEST

The apathy of the public toward the civil defense program has been reflected in the recent congressional reduction of appropriations for the FCDA. The cuts have eliminated or crippled many of the proposed activities in the federal aspect of the civil defense program. It has been proposed that one means of removing public apathy is to show the public exactly what an atomic bomb can and cannot do. Lack of interest in civil defense stems largely from a fatalistic attitude resulting from the well-known statement: "There is no defense against the atomic bomb."

According to Stewart Alsop,[1] it has been proposed by the FCDA that an explosion over a skeleton mock city be exposed to public view via personal inspection or television. If buildings of various types (frame, brick, concrete) were constructed at varying distances from the explosion point, the type of damage occurring and the radius of action would be presented in the most vivid fashion. Such an exhibition might show that, despite the great power of an atomic bomb, the damage resulting is of manageable proportions, and well worth reducing by an effective civil defense program.

[1] In his *New York Herald Tribune* column of May 20, 1951.

MINUTES TO MIDNIGHT

The International Control of Atomic Energy

Edited by EUGENE RABINOWITCH
Foreword by CARLOS P. ROMULO

THE *Bulletin of the Atomic Scientists* announces the publication of this 128-page book on the most crucial problem of our time: The International Control of Atomic Energy. Month by month, since its inception in 1945, the *Bulletin* has followed the attempt by the United Nations to find a way to secure the world against the threat of atomic warfare. It has published the important documents from the Truman-Attlee-King Declaration to the latest U.N. resolutions. It has carefully condensed the various plans for international control—the Acheson-Lilienthal Report, the Baruch Plan, the Soviet Proposals—summarized the reports of the United Nations Atomic Energy Commission, reported the debates with objectivity, and presented significant articles on the subject by leading scientists, statesmen, and political scientists. In MINUTES TO MIDNIGHT these documents and articles are gathered together in convenient form to give a complete, authoritative and unbiased account of the control negotiations. The Introduction and commentary is written by Dr. Eugene Rabinowitch, editor of the *Bulletin*. The material was selected by the Social Science Staff at the University of Chicago.

The purpose of MINUTES TO MIDNIGHT is to acquaint people with the actual course of the negotiations, with the large areas of agreement already reached, and with the true character of the disagreements which have obstructed this search for sanity.

MINUTES TO MIDNIGHT is of especial interest to
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